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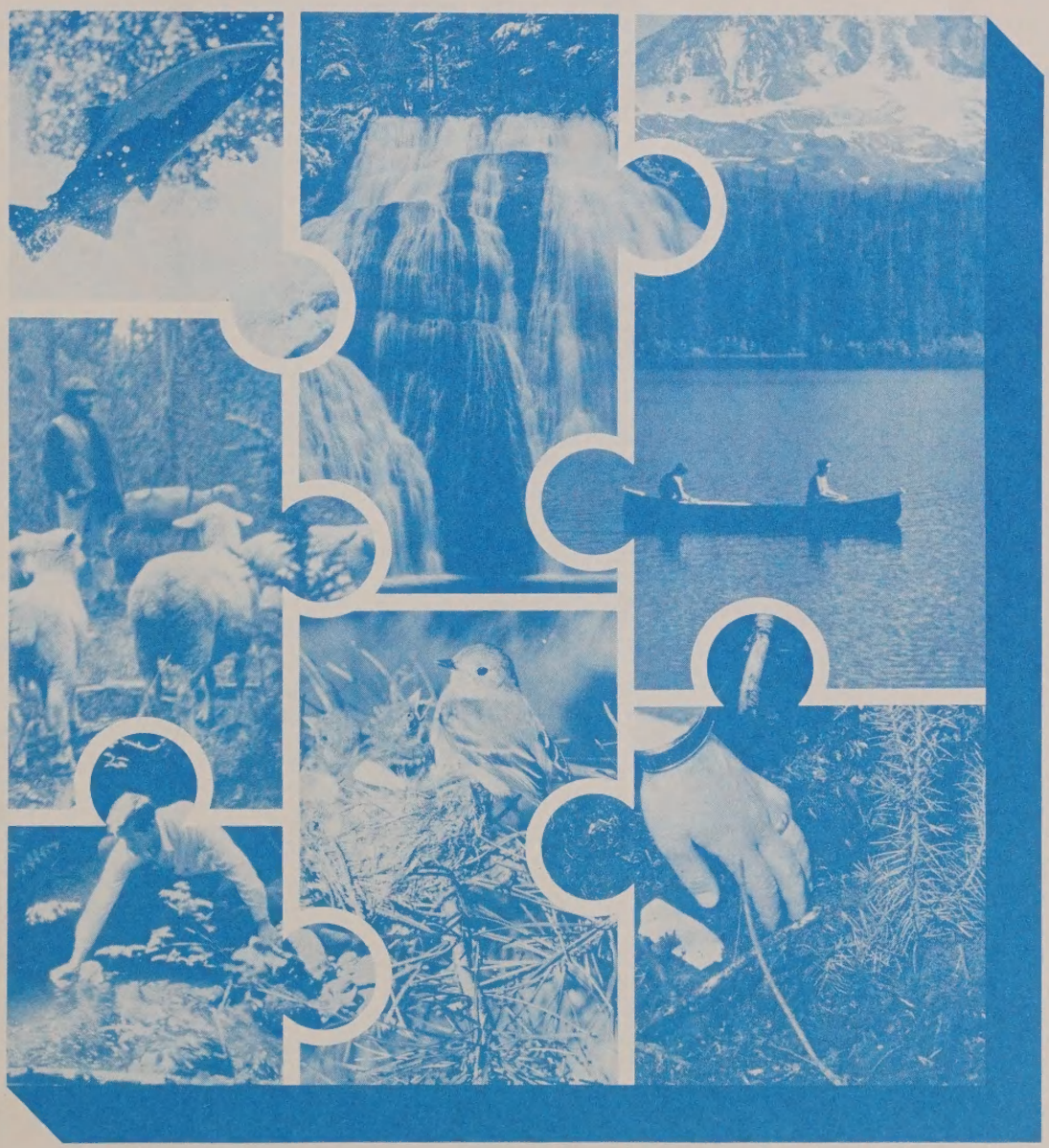
Forest Service

**Pacific
Northwest
Region**

November 1988

Managing Competing and Unwanted Vegetation

Final Environmental Impact Statement



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Final Environmental Impact Statement for

Managing Competing and Unwanted Vegetation

USDA Forest Service
Pacific Northwest Region
States of Oregon and Washington and
Portions of California and Idaho

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Cooperating Agency:	Environmental Protection Agency
Cooperating State Agencies:	Agencies of the States of Oregon and Washington have cooperated in the preparation of this Final Environmental Impact Statement.
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Abstract

The Forest Service, in compliance with the National Environmental Protection Act of 1969, is presenting eight alternative ways of managing competing and unwanted vegetation on the National Forests of the Pacific Northwest Region.

The alternatives are:

A manage competing and unwanted vegetation without chemical herbicides;

B all tools are available to manage vegetation;

C no vegetation management;

D manage vegetation by prevention and integrating natural ecosystem processes, herbicides are a last option;

E aerial application and specific herbicides are prohibited, and worker safety requirements are emphasized in managing vegetation;

F manage vegetation without the use of prescribed fire to treat logging slash;

G manage vegetation aggressively to maximize production of resources for human use; and

H manage vegetation using prevention and natural ecosystem processes, reducing reliance on herbicides. Fire for slash reduction also continues to decrease..Three herbicides are prohibited, and special worker safety requirements are emphasized.

Alternative H is the Forest Service's Preferred Alternative.

The effects of the alternatives on the physical and biological environment, on human health, on social and economic conditions, and on resource management are presented. A special appendix, Characterization and Management of Risks addresses those policy issues.

Note to Reviewers

A precedent established in court obliged reviewers participating in the National Environmental Policy Act (NEPA) process to alert the agency to their positions and contentions in a meaningful way. Also important to those concerned with the issues addressed in this EIS is another legal precedent, which established that environmental objections that could have been raised at the draft stage may be waived if they were not raised until after completion of the final environmental impact statement (FEIS).

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Summary

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Introduction

A new program for managing competing and unwanted vegetation is being developed by the Pacific Northwest Region (Oregon and Washington) of the USDA Forest Service. This Environmental Impact Statement (EIS) replaces the 1981 Vegetation Management Environmental Impact Statement for the Region.

Competing and unwanted vegetation occur in all ecological systems. Unwanted vegetation may include logging slash, roadside brush, or plants which compete for nutrients and sunlight with more desirable species. These plants play various roles in the system, some of which are useful to society. Forest managers recognize that an understanding of the overall ecological system is key to the effective management of unwanted vegetation.

To that end, a Final Environmental Impact Statement for Managing Competing and Unwanted Vegetation has been prepared by the Forest Service. The decisions that will be made based on this Final EIS will guide management on all National Forests in Oregon and Washington. They will provide information and policies that will be considered in preparation of Land and Resource Management Plans for each National Forest.

This summary highlights the major points of the Final EIS. It contains a brief description of the purpose of, and need for, an Environmental Impact Statement; an explanation of vegetation management; a description of public involvement in the decision-making process; a comparison of the alternatives; and a summary of the details of the recommended alternative.

The summary is only an overview of the Final EIS. Many of you will want more information concerning this far-reaching decision. The complete EIS includes:

Summary: an overview of the final EIS;

Chapter I: an introduction to vegetation management, the public and management issues surrounding it, "the NEPA process", and other considerations;

Chapter II: the presentation and comparison of the alternatives, with information on how they would be implemented, including measures to protect the environment;

Chapter III: descriptions of the physical and biological setting of the Pacific Northwest Region; and

Chapter IV: changes likely to occur with implementation of any of the alternatives.

Detailed supporting and background information is presented in 12 appendices:

A Timber Growth and Yield Analysis
B Economic Efficiency Analysis
C Herbicide Use and Efficacy
D Human Health Risk Assessment (Quantitative)
E Silviculture Program Effects
F Rangelands of the Pacific Northwest Region
G Vegetation Management Activities
H Resource Programs and Human Health Risk Assessment (Qualitative)
I Public Participation and Consultation
J Wildlife Use of Six Broad Forest Types
K Method Used to Project Particulate Emissions from Prescribed Burning

There is also a special separate appendix, Characterization and Management of Risk.

To receive a complete final copy, contact your nearest National Forest head-quarters office. The names, addresses, and telephone numbers of all the Forest headquarters (and the Regional Office in Portland) are listed at the end of this summary.



Pacific Northwest Region
Vegetation Management
Environmental Impact Statement

The Process

1. PLANNING & ORGANIZING

- Process Management Meeting 5/86
- Recommendations
- Decision
- Notice of Intent 6/86
- Scoping
- Management Objectives for Environmental Analysis 7/86

2. ENVIRONMENTAL ANALYSIS

- Interdisciplinary Team Meeting #1 Scoping 8/86
- Tight Outline of E.I.S. Issues Alternatives Data Needs 9/86
- Public Participation Internal Review 10/86
- Interdisciplinary Team Meeting #2 Environmental Analysis
- Rough Draft of E.I.S. and Outline of Record of Decision 3/87
- Internal Review, Public Participation 4/87
- Interdisciplinary Team Meeting #3 Documentation 5/87
- Public Release of Draft E.I.S. 9/87

3. DECISION MAKING

- Public Comment Period Internal Review
- Analysis of Comments
- Interdisciplinary Team Meeting #4 Response to Comments 6/88
- Internal Review Final E.I.S. Record of Decision 9/88
- Decision by Responsible Official 10/88
- Public Release of Final E.I.S and Record of Decision (or New Draft E.I.S) (or Supplement) 11/88
- Start of Vegetation Management Activities spring '89

Summary

The Pacific Northwest Region of the USDA Forest Service is headquartered in Portland, Oregon. It includes Oregon, Washington, and parts of a few counties in California and Idaho. In this Region, the Forest Service administers 19 National Forests (including one National Grassland) totalling 24.5 million acres.

Terrain and vegetation vary widely across the Region. There is a great variety of landforms from coastal dunes and flat grasslands to rolling hills, steep ridges, and volcanos. Natural vegetation ranges from the Olympic rain forest to interior high deserts.

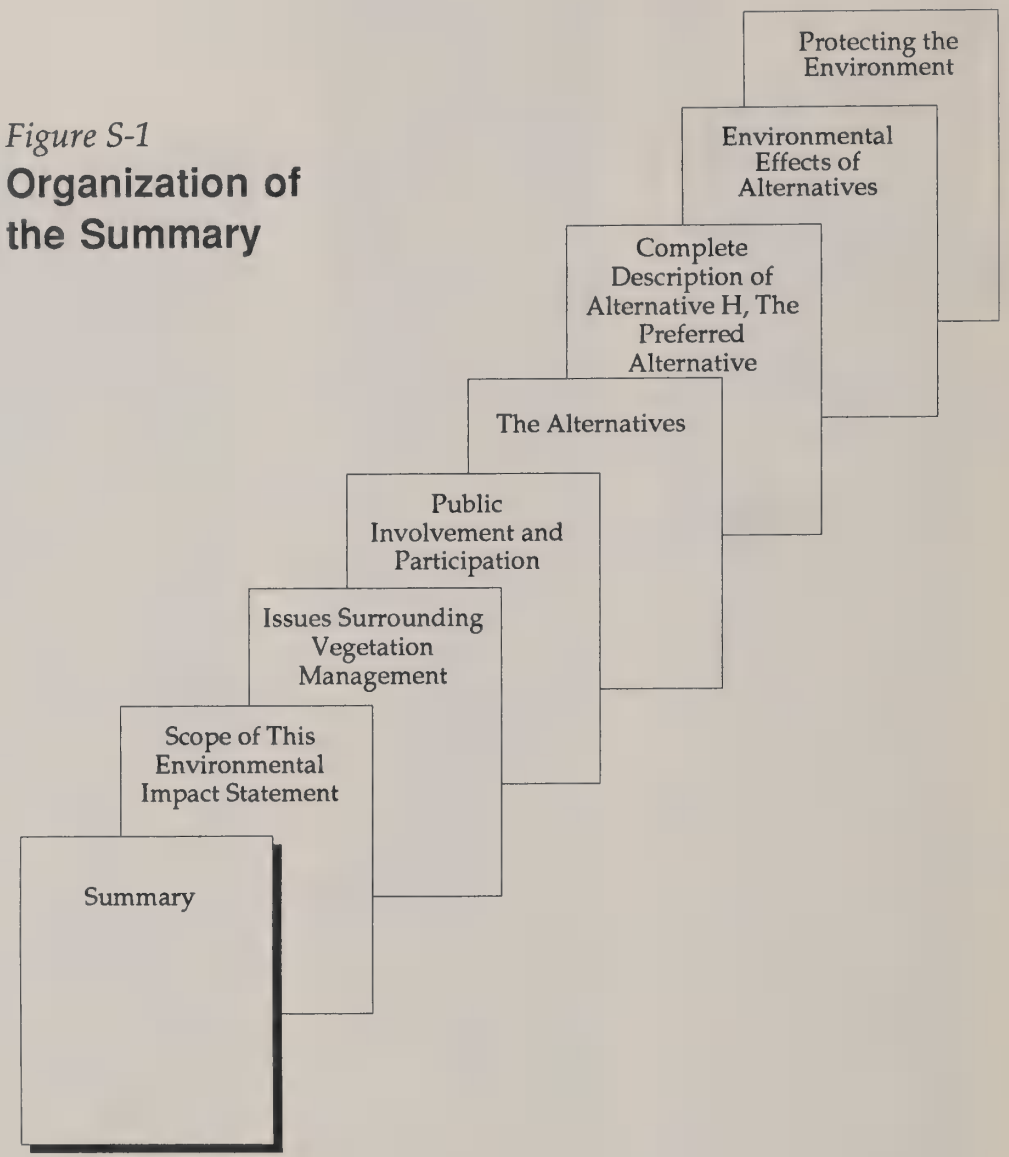
Managing competing and unwanted vegetation is a major effort in the management of National Forests in the Pacific Northwest. The effort involves many activities such as preparing sites for planting trees or clearing away roadside brush. Each activity uses different methods to treat vegetation including burning with prescribed fire, cutting by hand, crushing with heavy equipment, or spraying with herbicides.

Decisions based on the Final Environmental Impact Statement could affect future Forest Plans. Both existing plans and those being prepared assume that all methods of managing competing and unwanted vegetation are available. If the new vegetation management program would significantly change decisions made on the way lands and resources would be managed on a National Forest, then the Forest Plans will be amended as needed.

Information in this summary is arranged as follows:

Figure S-1

Organization of the Summary



Scope Of This Final Environmental Impact Statement

At the end of the environmental analysis process documented in both the Draft and Final Environmental Impact Statements, the Regional Forester will select a program for managing vegetation. This program affects all National Forest activities involving the management of competing and unwanted vegetation, including logging residue (slash) that is managed for purposes of reforestation. These activities include:

- preparing sites for planting trees;
- releasing young conifers from competing vegetation;
- managing fuel hazards and preventing wildfires;
- improving range conditions for livestock;
- controlling noxious weeds;
- improving wildlife habitat;
- maintaining recreation and administrative facilities;
- maintaining roadsides and utility corridors; and
- supporting the tree genetics and research programs.

Many of the items listed are major activities involving a variety of actions and tasks. Only the portions of each activity that involve managing competing and unwanted vegetation are affected by decisions made as a result of this Final EIS. Activities in Forest Service tree nurseries are not included.

Methods of vegetation management considered here include the use of herbicides, prescribed burning, manual work, biological treatments, and mechanical means.

Efforts to control or eradicate unwanted vegetation may signifcantly affect the natural and human environment. The purpose of an environmental impact statement such as this is to examine those impacts.

Issues Surrounding Vegetation Management

In an environmental analysis, issues play a substantial role in forming the alternatives, raising questions for analysis, and focusing thought and discussion when selecting the preferred alternative.

The following seven issues were distilled from the comments of individual citizens, elected officials, interested groups, government agencies, and Forest Service employees. These people participated in early public involvement efforts that provided information about issues this environmental impact statement should address, and about ways the public could be involved throughout the whole analysis process. They include:

Human Health

Human health issues have been a major focus of controversy over vegetation management practices in recent years. Much attention has centered on the safety of using herbicides for vegetation control. The effects of smoke from prescribed burning has also emerged as an important health issue, along with the need to evaluate the health and safety effects of manual methods for managing vegetation.

Public Participation

Public participation is an important element of a successful program for managing public lands and natural resources. Public participation in vegetation management decision-making is an especially important and sensitive issue because of past conflict-charged relations. Members of the public asked to be (and were) included throughout the development of these Draft and Final Environmental Impact Statements.

They also asked for continuing participation and information sharing after the decision has been made, for participation in site-specific, project level planning, and for readable, clear analyses and documents. Public participation played a very important role in the development of this Final EIS. More detail follows in a separate section of this summary, with complete information in the EIS itself. Responses to public comments on the Draft EIS are contained in Appendix I.

Social and Economic Effects

Vegetation management activities have direct effects on employment and the quality of community life. The vegetation management program influences how much timber the Region can grow and harvest. The quality of grazing, water, recreation, and wildlife habitat may also be affected. These Forest activities support jobs directly and indirectly in many sectors of the economy. The program chosen will have economic effects as well as effects on the general well-being of communities.

Cost and Benefit Analysis

National Forests offer a wide range of goods and services. Some of those goods and services are sold or leased; others are provided at no fee. It also takes money, people, and resources to manage the Forests. The concern in this issue is that money and resources be wisely managed and put to the most effective and beneficial use.

Environmental Effects

All facets of the environment contribute to providing products such as quality air, water, and timber. To produce a continuing supply of these and other benefits, the ecosystem must remain healthy. There is concern both by the public and the Forest Service about the physical and biological effects of vegetation management techniques on the environment.

Effectiveness of Techniques

There are many different vegetation management techniques and many different site characteristics and conditions. It is important to match the appropriate technique to the circumstances and particular site. Sharing knowledge of current techniques, products, and technology is an important aspect of this match. In addition, measures must be taken to assure that desired results are being achieved.

Interagency Coordination

Agencies at all levels of government have a shared interest in vegetation management. Many agencies have vegetation management

responsibilities which overlap those of the Forest Service. These may be directly or indirectly affected by decisions made as the result of an en-vironmental analysis. Coordination with national, state, and local agencies is important in developing a program for vegetation management.

Public Involvement and Participation

From the beginning of this environmental analysis, the public has been involved. Public participation led to the identification of the issues we dealt with throughout the process. The Draft EIS was submitted to the public for review and comment in October, 1987. The comment period ended February 15, 1988.

Public Response to the Draft Environmental Impact Statement

About 4,900 responses were received from 29 states. Of these, 3,500 were "form letters" and the remainder were individually written. The vast majority of them were from Oregon (4,100) and Washington (600). Letters came from individuals and families, environmental groups, timber industry businesses, associations and unions, county and state elected officials, businesses or business groups, city, state, and federal agencies, and civic groups, among others.

Analysis of Responses

The next step in the process was content analysis. This is a process where each response is read to identify the key points made. Then this content is coded, and similar comments are grouped together. A coding team worked nearly three weeks reading and coding letters. The coded comments were entered into a computer which stores the information for sorting and tabulation. The comments were evaluated by the Vegetation Management Team, and recommendations were developed for responding to the issues raised. (See Appendix I for more information.)

One Result: a New Alternative

Seven alternative combinations for managing competing and unwanted vegetation were presented for review in the Draft EIS. Based on the comments received, the team formulated a new alternative for recommendation to the Regional Forester. The highlights of new Alternative H are included (along with the descriptions of the original seven alternatives) in the next section of the summary. A full description of Alternative H follows next after brief explanations of all the alternatives and the environmental effects.

Figure S–2

Overview of the Alternatives

Alternatives	A	B	C	D
Manages Competing and Unwanted Vegetation	...with no herbicides.	...with all effective tools.	...rarely, and and only for human safety.	...emphasizing prevention and the use of natural processes.
Time for Action	At first sign before damage occurs	At first sign before damage occurs.	No action unless vegetation threatens public safety.	At first clear sign of potentially significant damage.
Project Design	*Prevention and correction both o.k.; herbicides will not be used.	Prevention and correction both o.k.; all tools and methods available.	Correction only; fire and herbicides both prohibited.	Prevention is preferred; herbicides available as a last option.

** "Prevention" and "correction" are two strategies for managing vegetation. Successful prevention keeps vegetation problems from getting to the point where they require correction.*

*** Forest Service preferred alternative..*

			 **
...with restricted use of herbicides and special worker safety.	...with no burning for silviculture.	...aggressively, with all tools.	...with all tools. Non-herbicide methods preferred. Using special herbicides requires special consideration.
At first sign, before significant damage occurs.	At first sign, before damage occurs.	At first sign, before damage occurs.	Evaluate early stages of main project. Act when evidence suggests growth loss or significant damage will occur.
Prevention is preferred; some herbicides prohibited, no aerial application; manual use restricted.	Prevention and correction o.k.; fire will not be used to prepare planting sites.	Prevention and correction o.k.; all tools and methods freely available.	Prevention is emphasized. Reduce reliance on herbicides, and on prescribed fire for treatment of slash. Three herbicides prohibited.

The Alternatives

Alternative A

This alternative is designed to eliminate all risk associated with the use of herbicides. Other effective and efficient techniques would be used in managing competing and unwanted vegetation.

In compliance with a 1984 U.S. District Court injunction, the Forest Service in the Pacific Northwest currently cannot use herbicides. Alternative A approximates this current vegetation management program carried into the future.

Alternative B

Under Alternative B, all effective and efficient techniques for managing competing and unwanted vegetation are available, consistent with the direction provided in applicable land and resource management plans.

The management of competing and unwanted vegetation specified in this alternative approximates the direction presented in proposed Forest Plans. Alternative B and the fiscal year 1989 program serve as the reference for comparison of budgets, outputs, and vegetation management activities for all other alternatives.

Alternative C

The vegetation management approach here is one of "no action" unless public safety is clearly and directly threatened. For example, hazard trees would be removed from campgrounds and roadside brushing would be done to maintain safe travel, but virtually none of the vegetation management normally associated with forest management would be done.

There is virtually no active intervention to manage competing and unwanted vegetation in Alternative C. Only situations that pose a direct threat to public safety will trigger action to suppress unwanted vegetation. In these cases, neither herbicides nor fire would be used.

Alternative D

The key to this alternative is the prevention of problem vegetation conditions through the integration of natural ecosystem processes into management of competing and unwanted vegetation. In Alternative D, vegetation management emphasizes leaving the least negative impact on the natural environment while producing products and amenities for human use.

The implementation of this alternative will involve early prevention measures, monitoring of sites, and frequent evaluations of conditions and practices. Vegetation is managed to avoid the need for corrective measures. However, correction, if needed, is done in a way to least alter natural ecosystems and processes.

Alternative E

This alternative is designed to reduce the risks of herbicide use to people and to improve the safety of forest workers when they apply herbicides and cut vegetation. No aerial application of herbicides is permitted, specific herbicides are prohibited, and additional safety requirements for workers are imposed.

Alternative F

This alternative is designed to manage competing and unwanted vegetation without the use of prescribed fire for silvicultural purposes. All other effective and efficient techniques of vegetation management are available. The burning of logging slash would be allowed for reducing wildfire hazards. Residue utilization is encouraged in place of burning, and burning of chemically treated vegetation is prohibited.

Alternative G

This Alternative manages competing and unwanted vegetation more aggressively than Alternative B. The emphasis is on maximum production of all forest resources for human use. All cost-efficient techniques for managing vegetation are available. It stresses looking for opportunities to increase timber and forage production (through vegetation management) beyond that predicted by the Forest Plans.

Alternative H (the Preferred Alternative)

This alternative combines a number of features of the seven original alternatives. Under Alternative H, we will manage vegetation with all tools, while reducing the reliance on herbicides, and on prescribed burning for reforestation purposes. Herbicides and prescribed burning will be used only when other methods would not be effective or when their costs would be unreasonable. Vegetation treated with herbicides will not be burned for at least one year following application. Outputs of forest commodities will approximate those of the applicable land and resource management plans.

Figure S-3

Activity and Implications by Alternative

Alternative	A	B	C
Acres managed annually for competing and unwanted vegetation:			
Total	552,100	553,000	86,600
Using herbicides	0	59,900	0
Using mechanical methods	184,600	167,200	44,900
Using manual methods	99,000	77,800	17,700
Using biological methods	14,800	4,300	3,800
Using prescribed fire	217,800	202,000	0
Receiving no treatment	24,400	19,900	15,600
Other	11,500	14,100	4,800
Anticipated Number of Worker Accidents Per Year (from combined use of manual methods and prescribed burning, by alternative):			
Minor injuries	1,250	1,053	189
Major injuries	30	29	3
Emissions from Prescribed Fires (Change from 1983-85):			
West-side	36% less	33% less	no burning
East-side	33% less	35% less	for veg. management
Long-Term Sustained Yield Capacity: (Change from Alt. B in million board feet)	95 to 125 less	0	1,000-2,000 less
Present Net Value: (Change from Alt. B in million dollars)	468 less	0	3,877 lower
Change in Jobs: (Change from Alt. B)	1,100 fewer	0	21,700 fewer

Unit definitions, data sources, and assumptions discussed in preceding text.

D	E	F	G	H
380,500	548,600	566,400	579,600	543,248
26,800	47,900	64,100	76,600	51,492
111,600	166,900	201,000	155,600	162,018
57,800	95,100	80,100	85,700	79,658
18,700	5,900	8,300	6,900	7,445
125,800	194,000	175,800	202,000	202,017
23,800	24,100	36,100	21,500	31,770
16,000	14,700	11,000	18,300	8,848
741	1,152	1,004	1,126	1,017
19	27	25	30	26
63% less	46% less	63% less	35% less	63% less
60% less	37% less	53% less	31% less	60% less
55-85 less	35-65 less	95-125 less	95-125 more	0
246 less	132 lower	322 lower	24 higher	4 less
3,100 fewer	1,300 fewer	3,100 fewer	2,600 more	500 fewer

Environmental Effects of Alternatives

The analysis focuses on five methods of managing competing and unwanted vegetation (use of herbicides; mechanical; manual; biological, cultural and grazing; and prescribed fire) to examine their effects on the environment. The analysis shows that at the project level, each method of managing competing and unwanted vegetation has its own environmental effects. However, mitigation measures have been established for each method to prevent serious negative environmental effects. Therefore, no single method is expected to cause more environmental impacts than another.

Because this environmental impact statement examines alternative programs for managing competing and unwanted vegetation, it is also concerned with how a series of projects conducted over a period of years could affect the environment. From this program point of view, there are three sources for potential environmental effects:

- human health risks from using or not using herbicides;
- air pollution from prescribed fires; and
- economic effects from variations in timber production between the alternatives.

Since each alternative was constructed to respond to a different issue, each has its own set of environmental effects. The analysis of each alternative addresses the effects of different methods of vegetation management on the physical, biological, social, and economic components of the environment.

Mitigation measures were also developed to prevent adverse environmental impacts. (The specific effects of individual projects are not assessed in this Final EIS because they will be addressed at the local level in site-specific environmental analyses.)

Chapter IV in the Final Environmental Impact Statement presents the environmental consequences in detail. Chapter II contains a complete description of all alternatives along with a detailed comparison of them in terms of issues. The preceding Figure S-4 presents a summary of the major elements of that comparison.

Complete Description of Alternative H, the Preferred Alternative

Purpose and Theme

The purpose of this alternative is to conduct a Regional vegetation management program so that it: 1) protects human health; 2) promotes long-term health and productivity of forest ecosystems; and 3) meets the goals and objectives of land management plans.

The theme here is to reduce the reliance on herbicides, to continue to reduce the use of fire for treating slash, and to support providing goods and services at high levels.

To achieve its purposes and theme, this alternative emphasizes preventing vegetation management problems. All methods for managing competing and unwanted vegetation will be available. Protecting rural communities and wildernesses from the deleterious effects of smoke is a high priority. This alternative also requires early involvement of the public to help set project goals, conduct environmental analysis, observe project implementation, and to monitor the results of projects.

Time for Action

The intent of this alternative is to detect and resolve vegetation management problems before they cause serious losses or require large correction projects. This calls for evaluating the need for action when problems are expected. The evaluation should include site-specific surveys and documented local experience. Then, when the evaluations verify that the expected problems are likely to occur, action will be taken. This approach will help managers to detect and control vegetation problems before they cause damage.

At times, results of the evaluation may be inconclusive and managers won't be sure that serious damage will occur. Managers may then elect to defer action until it is clear that a problem is developing. In some cases, waiting may reveal that the damage is minimal and that further action is not needed.

Project Design

The factors to consider in designing projects include:

Strategy: This approach emphasizes the use of prevention and natural processes to manage competing and unwanted vegetation. It requires creative solutions that use the biological and technical knowledge gained through monitoring. Managers will need to anticipate potential vegetation management problems and take steps to avoid them. When corrective measures are needed, those projects should be designed to move toward preventive strategies.

The planning stage for any project (such as timber harvest, road construction, or range improvement) is the most appropriate time for implementing a prevention strategy. For example, the site analysis may identify a plant association known for its potential to compete with crop trees. A harvest prescription may then include measures to limit the vigor of competing vegetation, be designed to reduce the need for subsequent corrective action (in this case, release), and result in lower overall costs.

Human Health Risks: The evaluation of human health risks, including exposure to hazardous substances and injuries, is an important factor in designing projects and in selecting vegetation management methods. All methods that are being considered will be analyzed prior to use for potential direct and indirect effects on human health. Herbicides and prescribed fire for slash treatment will be used only when necessary. Selected methods will present low risk when compared to other methods that could also meet the design criteria.

The protection of recreational and rural residential populations from exposure to smoke from forestry burning will be given special attention. All practicable means of smoke management (reduction, avoidance, and scheduling) will be employed.

Environmental Effects: Adverse effects will be minimized by using 1) site-specific environmental assessments, 2) mitigation measures described in this EIS, and 3) natural processes. The site-specific environmental assessments will address potential environmental effects for proposed projects. They will also help identify project designs and mitigation measures that will be necessary to minimize adverse effects. The diversity and integrity of the natural ecosystem and long-term productivity are major considerations in this process.

Tools Available: This alternative makes all tools available while at the same time working toward the goal of reducing reliance on herbicides. Using herbicides requires special considerations to establish their need, assess the risks, and to implement special mitigation measures. Herbicides will be used only when necessary; that is, when other methods would not be practicable or when their costs would be unreasonable. As a part of the site-specific NEPA process, the responsible officials will document the criteria they used in establishing the need for using herbicides.

Vegetation that has been treated with herbicides within the prior year will not be burned, and utilizing management activity-generated residues is preferred to burning. However, prescribed burning is avail-

able since it is often the preferred method for reducing the natural accumulation of dead plant debris, maintaining ecosystems at a more productive stage of succession, and regenerating decadent, fire-dependent plant communities.

Two of the herbicides evaluated for use, diuron and fosamine, had insufficient data to support toxicological analysis. A third herbicide, amitrole, poses unacceptable cancer risks under normal exposure scenarios. None of the three herbicides will be used under this alternative.

The use of all tools and methods requires operator safety training and proper protective gear. The Forest Service will coordinate vegetation management activities with its neighbors. In addition, all contracts will provide for worker education and safety (including the use of protective clothing) at a level equivalent to that specified for Forest Service employees.

Forest managers will continue to evaluate and monitor tools and intensity of application. Methods used will continue to change based on new research, analysis of completed projects, improvements in technology, and public need.

Budget and Costs: The costs of the activities will vary, but will be within the budgets that can be reasonably expected. In selecting vegetation management methods for projects, human health risks, environmental effects, project-specific decision criteria, and cost-efficiency will be considered .

Outputs: Vegetation management activities will be those required to support the production of forest goods and services at a level approximating those of the applicable land and resource management plans.

Protecting the Environment

As an integral part of developing the Draft EIS, mitigation measures were developed to reduce, avoid, or minimize potentially adverse impacts on the environment which might result from vegetation management activities.

The mitigation measures were developed using Federal laws and regulations, the intent of state resource laws, existing direction found in Forest Service manuals and handbooks, land and resource management plans, resource management experience, and research findings.

Several mitigation measures cover all vegetation management activities, regardless of method. Others apply to a particular method. If a

method is used in an alternative, the mitigating measures associated with that method will be applied.

What follows is a summary of the mitigation measures that were developed. For more information, refer to Mitigation Measures and Vegetation Management Methods in Chapter II of the Final Environmental Impact Statement. Additional information on the effectiveness and impacts of mitigation measures is in Chapter IV, Environmental Consequences.

Mitigation Measures

Before using any method of vegetation management, Forest Service personnel will be required to:

- conduct an environmental analysis (including scoping) as required in Forest Service Manual 1950, for each proposed project;
- prepare a human health risk management plan for each project; and
- provide training and quality control at regional, forest, and district offices.

The mitigation measures that apply to all silvicultural vegetation management require:

- a written silvicultural prescription prepared or approved by a certified silviculturist; and
- a site-specific diagnosis that meets Forest Service Silvicultural Practices Handbook (2409.17) standards and treatment needs (2409.26c).

Biological Methods: When using livestock to control vegetation, the Forest Service will notify affected water users, and assure strict control of livestock near riparian areas. The release of insects to control specific vegetation requires coordination with state and Federal agencies. Site analysis will explore the seeding of compatible plants and the use of genetically superior seedlings, natural seedlings, and advance regeneration as ways to prevent or minimize the need for future vegetation management.

Manual Methods: When workers with hand and power tools are used to treat vegetation, safety risks will be analyzed and incorporated into the human health risk management plan.

Mechanical Methods: When mechanical methods of treating unwanted vegetation and logging residues are used, tractors will not be

used on steep slopes, on highly compactible soils, on erodible soils in municipal watersheds, or during conditions with high risks to soils. Buffers of vegetation will be left along streams, lakes, and wetlands to minimize sedimentation. Logging residue will not be piled in stream flood plains.

Use of Herbicides: Some of the alternatives would allow use of herbicides; some would not. If herbicides are used, there will be strict adherence to:

- EPA label instructions for the herbicide;
- applicable state and Federal laws; and
- site-specific mitigation measures.

If herbicides are used, these specific measures will be implemented:

- downstream water users and adjacent landowners will be notified of planned use of herbicides;
- amitrole, diuron, and fosamine will not be used in the Region's vegetation management program;
- dalapon will not be used in roadside vegetation management nor in any other situation where its use could result in exposure to the public, either through routine operations or accidents;
- female workers (either Forest Service employees or contract workers) will not be used as mixers or loaders in atrazine or bromacil applications;
- female workers will not be used in backpack spray or hack-and-squirt applications for 2,4-D, glyphosate, dicamba, tebuthiuron, triclopyr, simazine, and bromacil;
- female workers will not be used in dalapon applications;
- atrazine will not be applied aerially;
- diesel oil will not be used in herbicide applications except as an adjuvant (not to exceed 5 percent of the spray mixture);
- kerosene will not be used in herbicide applications, except as an inert ingredient in the esther formulation of triclopyr;
- use herbicide formulations that contain only inert ingredients which are recognized as generally safe by EPA or which are of a low priority for testing by EPA. Use of other inerts (identified by

EPA as a high priority for testing or those that have been shown to be hazardous) requires full assessment of human health risks incorporated into the NEPA decision-making process;

- precautions against accidental leaks or spills will be taken;
- mixtures will be prepared and equipment will be cleaned in areas outside sensitive watersheds, where ground water will not be contaminated;
- protective clothing will be worn by all workers (both Forest Service employees and contract workers) involved in herbicide mixing, loading, backpack applications, and hack-and-squirt applications;
- public notification will be used for all applications requesting that people who know or suspect that they are hypersensitive to herbicides contact the Forest Service office proposing the project to determine appropriate risk management measures;
- workers (both Forest Service and contract) who know they are hypersensitive to herbicides will not be used for application projects. Workers who display symptoms of hypersensitivity to herbicides during application will be removed from the project;
- spray droplet size will be optimized to minimize drift;
- specified buffers will be left along streams, rivers, lakes, and wetlands;
- pilot vehicles will be used when transporting mixed herbicides (see Chapter II, Mitigation Measures);
- both worker and public exposure monitoring is required for all herbicide application projects. Pertinent details will be documented, including herbicides used, land areas treated, dates and times of applications, people involved and mitigation measures followed; and
- monitoring will be done to assure effectiveness of mitigation measures during spray operations.

Herbicide use will be in compliance with Forest Service Pesticide Use Manual (FSM 2150) direction. Forest Service Handbook standards will be followed, specifically:

- Chapter 2109.11 for planning projects;
- Chapter 2109.12 for storing, handling, and transporting herbicides and for spill prevention, cleanup, and disposal requirements;

- Chapter 2109.13 for defining worker training and experience requirements; and
- Chapter 6709.11 for identifying worker safety requirements.
- Individual National Forests will provide detailed guidance for large projects.
- Applicator training, testing, and licensing will be required to assure knowledge of herbicide uses, risks, and safety.
- Herbicide safety data sheets will be posted at storage facilities, in vehicles, and made available to workers.
- Skin contact with diesel oil and kerosene will be avoided.

Prescribed Fires: For the use of prescribed fire, extreme care will be taken to:

- avoid excessive consumption of litter and duff;
- reduce fuel consumption on steep and erodible slopes;
- leave unburned buffers of vegetation along streams;
- protect air quality, following all state and local regulations;
- avoid intrusion of smoke into state-identified sensitive areas;
- use the best available technology to reduce smoke;
- (in Oregon) comply with the Oregon State Smoke Management Plan and Implementation Plan;
- (in Washington) comply with the Washington State Smoke Management Plan and Implementation Plan; and
- vegetation treated with herbicides will not be burned for at least one year following treatment.

Unavoidable Adverse Effects

The implementation of any alternative would result in some adverse environmental effects which cannot be avoided. Standards and guidelines from Forest Plans, and mitigation measures developed in the Draft and Final Environmental Impact Statements, are intended to keep the extent and duration of these effects within acceptable levels, but adverse effects cannot be completely eliminated.

This Final EIS examines alternative programs for managing competing and unwanted vegetation, including logging residue. The focus of the environmental analysis here is on how a series of projects conducted over a period of years could affect the environment.

The environmental effects of the alternatives are presented in Chapter IV of the Final Environmental Impact Statement. The effects on the full range of environmental components and conditions are analyzed and presented. The effects on soil, wildlife, fish, timber, scenery, and other aspects are extensively portrayed.

There are three areas of central concern, and these have the potential for significant adverse effects:

1) human health risks;

2) degradation of air quality from fires; and

3) economic effects from changes in timber yields.

Human Health Risks

Human health risks exist for both workers and the public. The risks which workers face from vegetation management activities that were considered in the FEIS include:

- injury from the use of handtools and mechanical equipment in manual control of vegetation;
- illness or injury from exposure to smoke and fire in prescribed burning and wildfire suppression; and
- illness from exposure to herbicides.

Two groups—forest workers and the public—face exposure to herbicides and fire smoke. Worker exposures are far greater in quantity and duration for both herbicides and smoke, which is why worker exposure risks (as a group) are roughly equivalent to the risk to the rest of those affected (the general public).

Health risks to the public can come from accidental exposure to herbicides. Potential routes of exposure to herbicides are discussed in the Final EIS in detail. Greater numbers of people are exposed to smoke from prescribed fires or wildfires.

In addition to risks from herbicides and smoke, workers experience risk from accidents while using equipment and working in rough terrain. The number of predicted accidents is directly correlated with

the number of acres treated by manual means and the number of acres burned.

Air Quality

The amount of smoke produced from both prescribed fires and wildfires is estimated in the Final Environmental Impact Statement. The section on air quality in Chapter IV displays (for each alternative) the amount of fine particulate emissions expected from the use of prescribed fire.

Alternatives H, F, and D produce significantly less suspended particulates than the rest of the alternatives (except Alternative C). All of the alternatives, when applied on a Regional level, meet the requirements of the Washington and Oregon State Implementation Plans and the requirements of both states' Smoke Management Plans.

Economic Effects

Vegetation management activities can affect the long-term timber yield potential of the National Forests. The Forest planning process may translate these long-term effects into present or future changes in timber yields. This, along with the effects of other factors, can affect the level of economic activity in the Region.

There are a variety of economic effects associated with each alternative. One measure is the combined change in direct and indirect jobs in the Pacific Northwest. (Jobs as used in this analysis include both full- and part-time, temporary and permanent positions, without distinction.)

The effect of Alternative H on job opportunities is approximately 2 percent less, or about 500 positions. Alternative G shows an apparent 2 percent increase, and Alternative B would have no effect on the total annual employment.

The five other alternatives estimate a decrease greater than Alternative H in jobs over the coming decade. The total employment in Oregon and Washington is approximately three million.

Activity, Risk, and Benefits

Health risks to the public at large are roughly correlated with the overall level of vegetation management activity. The level of vegetation management activity also roughly correlates with the levels of economic productivity.

Other Adverse Effects

There is a potential for additional adverse effects beyond those described above. The following effects are not expected to be significant, as standards and guidelines and mitigating measures in the Forest Plans will be in effect, as well as the mitigating measures identified in the Final Environmental Impact Statement.

The additional adverse effects are usually minor, localized, and temporary. They include:

- a short-term reduction in air quality from dust, smoke, and engine emissions resulting from vegetation management activities (other than prescribed burning);
- a localized reduction in long-term site productivity from burning of logging slash;
- the acceleration of natural rates of land slides and sediment by soil-disturbing activities associated with the use of heavy equipment for vegetation management projects;
- a temporary increase in fire hazard from waste material left on the ground during vegetation management activities;
- the contamination of water sources due to increased human use of the Forest;
- a decrease in habitat for wildlife species (dependent on particular plant species and growth stages) due to vegetation management activities; and
- damage to soils by compaction from heavy equipment used for vegetation management.

Again, these effects are likely to be minor and short-lived. But if mitigation measures fail, these effects could be significant on a given site where they occur.

Conclusion

The publication of a Final Environmental Impact Statement concludes the second phase of the vegetation management program. After the Regional Forester selects the alternative that will guide vegetation management activities, the next step is implementation and monitoring. Continued public involvement is key to the success of this project.

This summary of the Final Environmental Impact Statement outlines the vegetation management program, the issues, and the proposed and recommended alternatives. It also provides an overview of the environmental effects of those alternatives. Specific details of these elements are found in the Final Environmental Impact Statement and Appendices, available from the Regional Office (in Portland) or from the headquarters of each National Forest in the Pacific Northwest Region.

If you have a question or comment concerning vegetation management now or in the future, please contact:

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National Forests of the Pacific Northwest Region



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Chapter I

Purpose and Need

Chapter I

What Reviewers Said

Use of the Forest Plan preferred alternatives and incorporating them in the analysis meant that the decision to select the Forests' preferred alternatives had already been made and mistakes in them affect the vegetation management planning process.

Our Response

We provide more information in Chapter I about how we are using the Forest Plan preferred alternatives. We do recognize that not all will become "selected" alternatives. Even so, the preferred Forest Plan alternatives provide us with the best estimate of future management activity levels. We recognize that the alternatives identified as preferred in the Draft Plans may not be the selected alternatives in the Final Plans.

Chapter I

Purpose and Need

Managing Competing And Unwanted Vegetation

Large parts of the National Forests in Oregon and Washington are actively managed to produce timber, recreational opportunities, forage, water, wildlife habitat, and safe travel.

The forester, like the farmer and gardener, has to cope with unwanted plants ("weeds") and unwanted plant debris.

Unwanted plants compete with desired plants for sunlight, water, nutrients, and space. Other unwanted plants are poisonous to people and animals. Plants sometimes grow along roadsides and other places where they pose a hazard to travel and safety. And the plant debris left after growth or harvest may pose a fire hazard or otherwise compete with desired plants and growth.

Unwanted vegetation is part of an ecological system. It plays various roles in the system, some of them useful to society. Forest managers recognize that an understanding of the overall ecological system is key to the effective management of unwanted vegetation.

Efforts to control vegetation could have important environmental impacts on the rest of the ecological system. An Environmental Impact Statement (EIS) examines those environmental impacts.

This Final Environmental Impact Statement (FEIS) presents eight alternate programs for managing competing and unwanted vegetation in the National Forests of Washington and Oregon. It displays the environmental impacts and management implications of these eight alternatives

This analysis was first presented in draft form for public review and comment. After carefully considering comments on the draft from the public, scientists, and government agencies, this FEIS was prepared. The Regional Forester used this document as the basis for selecting an alternative.

The Forest Service Pacific Northwest Region

The Pacific Northwest Region of the USDA Forest Service is headquartered in Portland, Oregon. It includes Oregon, Washington and parts of a few counties in California and Idaho. In the Pacific Northwest Region, the Forest Service administers 19 National Forests (including one National Grassland) totalling 24.5 million acres.

There are a wide variety of resource management objectives across the Region. Different sites are managed for mixes of timber production, human safety, scenic quality, livestock forage, wildlife habitat, and other objectives. Depending on the environmental conditions and the resource management goals for any specific site, some vegetation may be unwanted or may compete with desired plants.

A plant species may be essential on one site, and unwanted on another nearby. Brushy plants compete with Douglas-fir seedlings in some parts of the Coast Range; grasses and forbs compete with conifer seedlings on the East-side. Snags provide wildlife nests in the general forest, but pose a hazard in campgrounds. Many plants provide livestock and wildlife forage and browse when they are young, but are not palatable when they age. Plants that are valuable elsewhere may be a danger to travelers on roads when they restrict visibility and



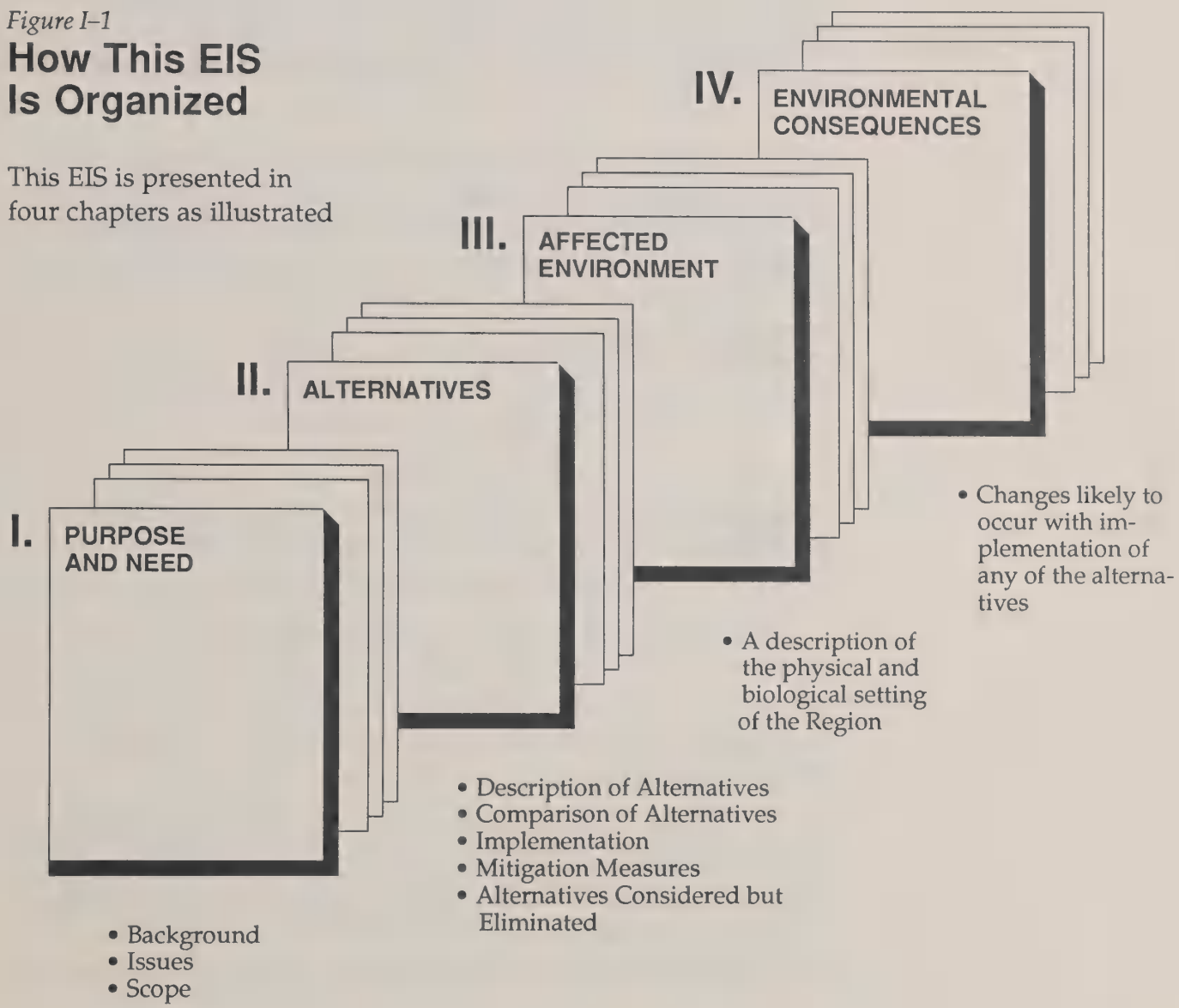
clearance. The need (or lack of need) for vegetation management activities depends on the specific objective and the specific setting.

This environmental impact statement looks at how the Forest Service manages unwanted and competing vegetation in all settings. Commercial timber species are not considered unwanted or competing vegetation, thus their management is not the direct focus of this EIS.

Figure I–1

How This EIS Is Organized

This EIS is presented in four chapters as illustrated



Additional detailed supporting and background information is presented in appendices:

A. Timber Growth and Yield Analysis
B. Economic Efficiency Analysis
C. Herbicide Use and Efficacy
D. Human Health Risk Assessment (Quantitative)
E. Silviculture Program Effects
F. Rangelands of the Pacific Northwest Region
G. Vegetation Management Activities
H. Resource Programs andHuman Health Risk Assessment (Qualitative)
I. Public Participation and Consultation
J. Wildlife Use of Six Broad Forest Types
K. Methodology Used to Project Particulate Emissions from Prescribed Burning
— Characterization and Management of Risk (a special appendix)

We do, however, consider the activities related to regeneration and disposal of slash from harvest and thinning operations.

Activities requiring vegetation management are discussed in detail in Appendix G.

Competing and unwanted vegetation can be managed using a range of strategies, from correction (where unwanted vegetation is controlled once it becomes a problem) to prevention (where problems —and the conditions leading to them—are anticipated and avoided). The strategies of maintenance (maintaining desired conditions by using minor actions) and of "no action" as appropriate are also useful approaches.

These strategies are discussed in greater detail in Chapter II.

Terrain and vegetation vary widely across the Region. There are a great variety of landforms, from coastal dunes and flat grasslands to rolling hills, steep ridges, and volcanoes. Natural vegetation ranges from the Olympic rain forest to interior high deserts.

The remainder of this chapter describes the purpose and need for this EIS. It is in two sections. The first outlines recent history, the scope of activities, and the issues that point to the need for this EIS. The second section presents related background information about the context of this EIS.

Three factors that are specific to the Region's vegetation management program point to the need and purpose of this EIS: 1) the history of events leading to it; 2) the relatively large scope of the vegetation management program; and 3) current issues surrounding the program. This section outlines each of these three factors in sequence.

History

On June 2, 1981, the Forest Service issued a Final Environmental Impact Statement (FEIS) and Record of Decision on the Methods of Managing Competing Vegetation. The FEIS provided alternatives designed around different combinations of methods considered appropriate for vegetation management. Analysis for that FEIS considered all vegetation management activities, excluding only timber harvest and tree nursery operation.

The management decision was to implement "full use of all methods of vegetation management, with reduced use of chemicals" (Alternative 2). The reduction in chemical use was expected through consideration of local concerns, and through adherence to current law, regulation, policy, and guidelines.

A suit was filed in US District Court for the District of Oregon on July 13, 1983 by Northwest Coalition for Alternatives to Pesticides (NCAP), Oregon Environmental Council, and Audubon Society of Portland against the Forest Service, Bureau of Land Management, and the Environmental Protection Agency.

Oregonians for Food and Shelter, an organization representing the business community, were intervenors on behalf of the government agencies.

A judgment was entered March 14, 1984, finding that, "The defend[a]nts have not prepared an adequate Worst Case Analysis, pursuant to their NEPA obligations." An injunction against the use of herbicides in the Pacific Northwest Region of the Forest Service and Bureau of Land Management Districts in the State of Oregon was issued, to be in effect until agency obligations were fulfilled.

Responding to the Court's directive, the Forest Service and the Bureau of Land Management prepared a comprehensive human health risk assessment for the use of herbicides, including a worst case analysis. This was intended to be part of a Supplement to the 1981 FEIS. After the preparation of that risk assessment, the Forest Service determined that a new EIS on the vegetation management program in the Pacific Northwest Region was needed.

The decision to prepare a new EIS was based on several factors. These included needs for:

1) re-evaluating the standards and guidelines in the 1981 document;
2) updating the issues and NEPA format requirements;
3) re-examining the management objectives for the entire vegetation management program, based on the current directionand philosophy;
4) responding to a new issue—air quality—by adding prescribed burning to the analysis;
5) including the human health risk assessment and worst-case analysis; and
6) considering the plaintiffs' remaining claims for relief in the July 13, 1983 suit.

On July 17, 1986, a Notice of Intent was published in the Federal Register to announce the preparation of a new EIS for a vegetation management program in the Pacific Northwest Region.

Scope of the Program

Managing competing and unwanted vegetation is a relatively large program that covers a wide range of management activities in the National Forests. These include:

- **Reforestation site preparation and release:** controlling vegetation that competes with young conifer seedlings.
- **Tree genetics support activities:** controlling vegetation in the vicinity of parent trees used for high quality seed production.
- **Research:** controlling vegetation on and around research sites, and where methods and techniques of managing vegetation are the subjects of investigation.
- **Recreation and administration facilities:** removing unwanted vegetation from campgrounds, recreation areas, and administration sites to provide safety and an aesthetically pleasing appearance.
- **Range improvement:** controlling plants (primarily invading brush species) that compete with desirable range plants.
- **Noxious weed control:** controlling weeds (classified as noxious by Federal or state agencies) to protect crops, livestock, and land.
- **Wildlife habitat improvement:** managing vegetation to benefit habitat for a wide variety of wildlife species.
- **Fire management activities:** reducing or eliminating vegetation and woody debris to aid in reforestation.
- **Rights-of-way maintenance:** controlling unwanted vegetation along highways and roads, land lines, trails, utility corridors and railroads for safety and to protect the investment.

A detailed description of each of these activities requiring the management of unwanted vegetation is presented in Appendix G.

There are five general methods used in managing competing and unwanted vegetation. All are considered in this environmental impact statement. They are:

- **herbicides**—the use of chemicals;
- **burning**—the use of prescribed fire;
- **biological methods and grazing**—the use of animals, insects, diseases, or other plants;
- **mechanical methods**—the use of powered machinery; and
- **manual methods**—the use of hand tools and hand-held power tools.

A detailed description of each of these methods is presented in Chapter II, Methods and Mitigation.

The Issues

The regulations for implementing the National Environmental Policy Act (NEPA) require that the important environmental issues be identified early in the process, and that these issues serve as a basis for the alternatives.

The issues were distilled from the comments of the general public, interested groups, government agencies, and Forest Service people who participated in early public involvement efforts. These comments provided information on the issues the EIS should address, and on how the public could be involved throughout the analysis process.

Major issues play a substantial role in forming the alternatives; in raising questions for analysis; and in focusing the thinking and discussion for selecting the preferred alternative.

After reviewing the material from the scoping (issue gathering) activities, and reading the comments from the public, agencies, and Forest Service employees, the interdisciplinary team identified seven major issues associated with the management of unwanted and competing vegetation.

Early on, during preparation of the draft EIS, the team evaluated the issues in light of ongoing comments. They found that the issues

continued to capture the essence of concerns about vegetation management.

Comments on the draft EIS received during the 120 days of the formal comment period were analyzed and considered by the interdisciplinary team in the process of developing this FEIS. While no new issues came to light, a number of issues received additional attention as the result of public comment.

For more information on issues of continuing concern, see the public comment analysis, and also the discussion of how the FEIS responds to substantive comments (Appendix I, Public Participation).

The seven public issues providing the focus for this EIS are:

- human health;
- public participation;
- social and economic effects;
- costs and benefits;
- effectiveness of techniques;
- environmental effects; and
- interagency coordination.

A discussion of the issues is presented below, along with some representative comments received from the public during their involvement in scoping efforts.

Human Health

Health issues related to the management of vegetation have been a major focus of debate during the past decade. Much attention has centered on the safety of herbicides used in vegetation control. The effects of smoke from prescribed burning has also emerged as an important health issue along with the need to evaluate the health effects of using non-chemical methods of managing vegetation.

A 1984 court ruling regarding the 1981 Forest Service environmental impact statement required the Forest Service to provide additional human health impact information pertaining to the use of herbicides for vegetation management. The ruling also required the agency to make its own evaluation of herbicides used in its programs, rather than depending (as it had in the past) upon the Environmental Protection Agency (EPA) for evaluation and registration of these herbicides.

Early public comments related to the human health issue include:

> "The heart of the issue is TRUST. You claim there are no persistent long term adverse health or environmental effects. How can you be sure and how can you convince me ... We are caught up in the ...ba[c]klash of other public entities that have promised health and safety to find out late it just wasn't so!"

> "[consider the] safety of persons doing the work (ie: risks of getting cut by a chain saw or ax vs. chemical contamination)".

The goal of the Forest Service in dealing with human health issues is to identify areas of concern where there is a potential for harm, and take appropriate measures to assure health and safety. Principal elements to consider in evaluating the impact of various vegetation management techniques on human health include analyzing accidental, chronic, and reported health risks. The scope of risks evaluated includes all five methods of vegetation management: use of herbicides, burning, manual, mechanical, and biological methods.



In addition, in the area of human health what we don't know is often as important as what we do know. The relative certainty of information and missing information has been carefully disclosed and considered.

Public Participation

Public participation is at the foundation of a successful program for managing public lands and natural resources. Public participation in vegetation management is an especially important and sensitive issue because of the past conflict-charged relations.

During the early scoping process where issues were identified, comments from the public emphasized "the need to be square with the public", and the need to establish "a conduit for release of preliminary plans and thinking...all along the way." In response, Forest Service

management has stated that, "The public [needs to] clearly understand the relationship of the EIS to site-specific decisions" toward the goal of "good relations with our Forest Service neighbors."

Members of the public asked that our public participation process include:

1) participation throughout development of this EIS;

2) ongoing participation and information sharing to continue after the decision has been made;

3) participation in site-specific, project level planning; and

4) readable, clear and understandable analyses and documents.

Conflict related to resource management can be lessened when management activities occur with full public involvement. Making information available to all interested parties (in a readable, well-organized way) is a major part of achieving this.

Full public involvement and objective, thorough analysis of all relevant factors are also essential elements for informing all concerned.

Social and Economic Effects

Vegetation management activities have direct effects on employment and the quality of community life. The vegetation management program may influence how much timber the National Forests can grow and harvest. The quantity or quality of grazing, water, and other resource uses may also be affected. In the case of noxious weeds, for instance, National Forest activities need to be coordinated with those of owners of adjacent or intermingled lands to be truly effective. If any of these parties do not act to control noxious weeds on lands they manage, forage managed by others may be adversely affected.

The sale and harvest of National Forest timber directly supports jobs in the harvesting, transportation, and manufacturing sectors. It also indirectly supports jobs in many other sectors. Fees are collected for other Forest uses and products. A portion (usually 25 percent) of the gross revenues from timber sales and other fees are returned to local governments for support of their road and school systems. These direct and indirect effects have important ramifications for the social and economic viability of Northwest communities.

Comments received from the public during their involvement in early scoping efforts and related to the social/economic issue include:

"Address long term loss of production and business enterprises which would result from noxious weeds occupying native

rangelands."

"Please consider labor intensive methods. Our society is in need of jobs."

"Emphasize 'greatest good to greatest number'."

". . . (3) effects on Oregon's employment, (4) effects on Oregon's community stability, (5) effects on federal revenues to the counties. . . "

Much of the discussion about the use of manual treatment, for example, has been in terms of jobs and other community effects. Advocates of use or non-use of a given method each argue that their approach is more beneficial for employment, either through increased employment in manual treatments or in employment in the wood products industry.

In addition to the economic effects of the alternatives, the different methods of managing vegetation on the National Forests have effects on the social cohesion and well-being of communities. Community conflict and anxiety over economic and environmental conditions may disrupt the stability of communities, and their ways of life may be changed.

The Forest Service is concerned with the economic and social health of local communities in the entire region. They are important factors in decision-making.

Costs and Benefits

The National Forests offer a wide range of goods and services. Some outputs (minerals and timber, for example) are sold or leased, and the proceeds are returned to the U. S. Treasury. The dollar benefit for these outputs is recognized as being their market value—the buyer's willingness-to-pay in a competitive environment. There are other benefits associated with the production of these commodities which are not dollar-quantified. These include job satisfaction, job security, household stability, and pride in workmanship.

Other uses of the Forests such as hunting, fishing, and hiking do not result in Forest receipts, yet they also have benefits associated with them. Recreationists certainly benefit from National Forests, often while paying only small user fees or none at all. Providing free use of the Forests for these purposes does not diminish their value to the public.

A great many people expressed the desire that their money and their resources (in the form of the National Forests) be wisely

managed. Some samples of the comments received include:

"A cost analysis for herbicides versus hand and mechanical methods of vegetation management should be done."

"Sound economic costs should be kept and used to weigh the value for each alternative."

"Insure the benefits of vegetative management outweigh the costs."

"A thorough economic analysis of all methods will be needed."

"Public funding will continue to be tight so the least cost method that will adequately do the job needs to be used."

It costs money to manage unwanted or competing vegetation on the National Forests. It also costs money not to manage unwanted or competing vegetation insofar as this lack of management contributes to a reduced flow of benefits. It is important to carefully and continually analyze these costs and benefits as a new program is being developed.

Effectiveness of Techniques

There are many different vegetation management techniques and many different site characteristics and conditions. The appropriate technique must be matched to the circumstance and particular site. Sharing knowledge of current techniques, products, and technology is an important aspect of this match. In addition, measures must be taken to assure the desired results are being achieved.

In determining what techniques are effective and striving to use what works, many variables need to be considered, including:

- recognizing site limitations and environmental variables;
- examining up-to-date technology and knowledge for all methods;
- recognizing the desirability of taking advantage of natural processes; and
- monitoring treatments to verify that vegetation management objectives are actually being achieved.

Comments received from the public during their involvement in early scoping efforts that relate to the "effectiveness" issue, include:

"Realize that there are natural limitations on treatment options."

"Use new technology gained during the District Court...injunction."

"Herbicides may be the only means to rehabilitate certain woody brush and hardwood sites."

"No-action will sometimes provide the most desirable results."

Current Forest Service policy guidelines recognize the important role of effective use of natural and non-chemical methods of treating competing and unwanted vegetation (Forest Service Manual 2150). Realistic limitations on substituting one method for another must also be recognized. In addition, a balance needs to be found between how effective a method is and how much it costs.

The relative effectiveness of techniques and individual products can be broadly defined in an environmental analysis and used as a guide for site-specific decision-making. In addition, this analysis can be used as a tool to share what has been learned and to act as a beginning avenue for considering new technologies and products as they are developed.

Environmental Effects

All facets of the environment contribute to providing high quality air and water, as well as a supply of timber, recreation, and wildlife. To produce a continuing supply of these and other benefits, the ecosystem must remain healthy. There is concern both inside and outside the Forest Service about the physical and biological effects on the environment when applying vegetation management techniques.

Almost every comment received during early public involvement efforts and on the draft EIS expressed concern about, and interest in, the quality of the human environment:

"Protection of watershed areas, whether large or relating to individual property owned within the National Forest, needs to be a major consideration."

"My main concern is long range productivity and management of the land."

"Effects of not managing vegetation as it relates to the high buildup of fuels, large fire risk, change of species mix over time."

"Cumulative effects of vegetation management combined with other activities (harvest) on quantity and quality of food and cover for wildlife."

"Lightest touch rather than heaviest hand".

Recognition of the interrelatedness of biological and physical aspects of the forest is essential in evaluating the effects of vegetation management. Trade-offs between the potential environmental effects of one vegetation management method and another are also an important consideration.



For example, the use of herbicides involves the risk of drift into surface water, but using a substitute method such as burning may lead to loss of organic matter and accelerated erosion.

Some effects, such as erosion and compaction, need evaluation on a long-term basis. A site's potential to produce forage (or any other product) may consistently decrease over long periods depending on which practices are used and how extensively they are applied.

Direct effects on the environment (such as a fire destroying trees) and indirect effects (the fire ultimately increasing the amount of forage available for deer) are another important component in the evaluation of environmental effects.

Many of the effects on the physical and biological environment can be tied to the extensive use (or non-use) of particular vegetation management methods. If herbicides are used regularly, certain effects may be predicted. If mechanical methods are the predominant technique, then certain other effects may result. What methods are used and how they are applied are both important in predicting environmental effects.

Interagency Coordination

Agencies at all levels of government have a shared interest in resource management through vegetation manipulation. Many agencies have responsibilities for vegetation management which overlap the Forest Service's responsibilities. Many may be directly affected by decisions made in an environmental analysis, while others are affected indirectly.

Federal agencies especially involved in vegetation management issues include the Bureau of Land Management (BLM) and the Environmental Protection Agency (EPA). The BLM is a joint defendant in the lawsuit (NCAP et al.) that eventually led to the District Court injunction on herbicide use. Strategies to meet NEPA requirements and other legal needs must be closely coordinated and developed with the BLM.

Program decisions made as a result of this environmental impact statement may have an impact on a number of state agencies that share either statutory authority or regulatory responsibilities. These include state departments of environmental quality, forestry, health, and agriculture. Coordination is particularly important in the areas of air quality, smoke management, and herbicide use, registration, and quality control. Decisions made for the vegetation management program may have implications or ripple effects for agencies dealing with agriculture or health services.

Local agencies have a stake in this environmental impact statement because of possible effects on payments to local governments, and on the effectiveness of programs such as noxious weed control. Coordination with county weed boards, conservation districts, and other county officials needs to be part of any interagency coordination effort. The coordination issue (particularly as it pertains to management of noxious weeds) was one of several issues receiving additional emphasis during the public comment period. Again, for specific information about public comments and their role in this EIS, see Appendix I.

Cooperation with state and federal agencies (established through provisions in NEPA) has been an important part of the development of theis EIS. Cooperative efforts led to clarification of agency responsibilities and improvements in communication.

Public Comments on the Draft EIS

The Draft EIS was released on October 15, 1987. The National Environmental Policy Act (NEPA) requires that all environmental analyses be open to public review. Interested individuals may obtain copies of the environmental impact statement and respond to the agency with their thoughts and comments.

According to NEPA regulations, a 45-day public comment period is required for the Vegetation Management Draft EIS. We decided on a longer 90-day review because of the broad scope and complexity of this particular document. A 30-day extension was granted in January, 1988, bringing the total review time to 120 days (October 15, 1987, through February 15, 1988).

We received over 5,000 responses to the draft EIS from 29 states and British Columbia. The responses came from individuals, organizations, associations, elected officials, and state and federal agencies. The majority were well-reasoned, thoughtful letters. These were valuable contributions to the final EIS.

As part of our commitment to working closely with people in the planning process, we responded to the letters we received. Using personal letters, we thanked people for their response, acknowledged points made, clarified information, and let them how we would be using their information in developing a final document.

Reviewers also commented that the draft EIS was well done, very readable, too big, confusing in places, in need of more analysis, and not written as a scientific document.

Reviewers commented that the process has been excellent and comprehensive. There were questions about the appropriateness of three preferred alternatives and our identification of a no action alternative.

The largest questions still remaining are 1) the potential for reduction of timber harvests and the associated implications of restrictions on the use of herbicides, and 2) the potential threat to humans and the environment if herbicides are used freely.

After reading and analyzing comments, the interdisciplinary team identified thirteen major question areas. These broad areas provided the focus of development of the final EIS.

1. What will the Record of Decision cover?
2. How will agency coordination work? Who will do what?
3. What will our policy be for the use of herbicides in municipal and domestic watersheds?
4. How can we improve our discussion and analysis of wildlife effects?
5. What can we do to improve the presentation of human health analysis?

6. What are the expected short-term effects, Forest-by-Forest, on timber allowable sale quantity effects?
7. How can we improve our discussion and analysis of noxious weeds?
8. Will we be changing or adding alternatives?
9. What constitutes effective implementation?
10. How do we achieve adequate monitoring?
11. How do we define integrated pest management and fit it into the FEIS?
12. How do we incorporate what we have learned about risk into decisions (both Regional and field-level) concerning vegetation management?
13. How will we integrate the FEIS into Forest plans?

The responses to these questions and the many other suggestions, comments, and questions are detailed in Appendix I.

The NEPA Process

The primary purpose of an environmental impact statement (EIS) is to assure that the policies and goals of the National Environmental Policy Act of 1969 (NEPA) are incorporated into federal actions. Environmental Impact Statements are written to make all pertinent environmental information and analyses available to public officials, cooperating agencies, and citizens before decisions are made and actions are taken.

All Forest Service activities that affect the physical and biological environment are regulated in part by NEPA.

NEPA is our basic national charter governing federal actions and the environment. It establishes several means to "create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."

NEPA is implemented through regulations in Title 40 of the Code of Federal Regulations, Parts 1500-1508 (40 CFR 1500-1508). The Forest Service implements NEPA according to "Environmental Policy and Procedures" Chapter 1950 in the Forest Service Manual (FSM 1950).

Further guidance is in the "NEPA Procedures Handbook" (FSH 1909.15). We will refer to these three documents throughout this EIS.

The process of analyzing and disclosing environmental consequences and then making and implementing a decision is often called "the NEPA process". It is a flexible but orderly process that is used to look at the environmental effects of a wide variety of actions. The process is spelled out in detail in Forest Service Manual 1950 and Handbook 1909.15, but the principal elements are described below.

Environmental Analysis

The core of the process is "environmental analysis". It is required for large projects and plans making major changes to the environment, as well as routine activities with a clear record of no significant environmental effects. The "environmental analysis" may be documented in a published "environmental impact statement", such as this one; documented in an "environmental assessment" (EA); or not documented at all if the activity is "categorically excluded" and has no significant effects. (See Figure I-2).

The first step in environmental analysis is "scoping". In scoping, the need, context, and issues related to a proposed action are considered. Public involvement needs are assessed, and public participation actions may be started at this point. The needed environmental analysis is planned, along with plans for documenting that analysis if it is to be presented in an EA or EIS (FSH 1909.15, Chapter 10). An interdisciplinary team may be formed to conduct the environmental analysis. This is the time when issues and analyses are made more explicit, and alternatives are explored.

Continued environmental analysis involves a number of steps. As scoping serves to assure the appropriateness and responsiveness of the environmental analysis, it continues throughout the analysis. The steps include:

- scoping;
- informing the public;
- collecting and interpreting data;
- developing alternatives;
- estimating effects of each alternative;
- evaluating the alternatives;
- identifying (a) preferred alternative(s);
- deciding to implement the action; and
- monitoring its effects and results.

As mentioned earlier, following the selection of a preferred alternative for action and the decision to implement it, the activity or project is monitored to assure that results and environmental protection are as planned, and that the activity or project is stopped or changed if needed to meet the desired protection or results. Monitoring may find and document conditions sufficient to start a new environmental analysis.

Unless "categorically excluded" from the need for documentation, the environmental analysis will be reported in a document. If the proposed action does not have significant environmental effects, the document is an "environmental assessment". If the actions might have significant effects (like the action proposed here), it is documented in an environmental impact statement such as this one.

Future Steps for This EIS

After review of the draft version of the EIS by the public and interested government agencies, and after the interdisciplinary team considered and responded to substantive comments on the analysis and the document, this final environmental impact statement (FEIS) on Managing Competing and Unwanted Vegetation was prepared and distributed.

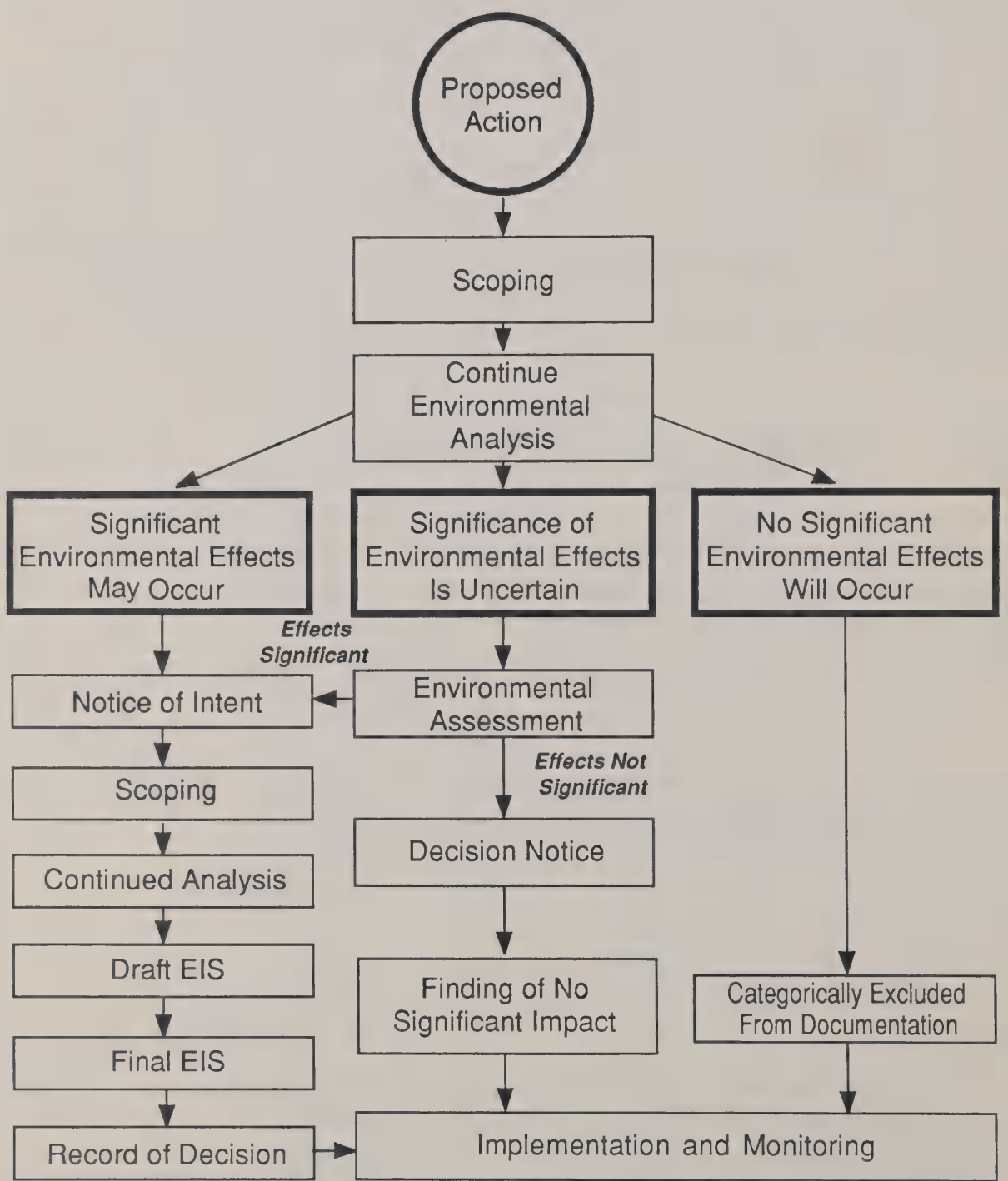
Based on the information in this document, the responsible official (the Regional Forester, in this case) selected a course of action based on the preferred alternative. The reasons for and conditions of this decision are presented in a document called the "Record of Decision".

Now, people working in the National Forests will begin implementing the program selected, keeping a close watch on the environmental effects and results of these management activities on the environment.

Over the next several years, the vegetation management program in the Pacific Northwest Region will incorporate hundreds of site-specific projects across the Region. The environmental consequences (effects) of each one of them will be different. These effects depend on the characteristics of the land, vegetation, and animals on that site; the weather and the time of year; and on how the activity is conducted.

The environmental consequences particular to each project and site will be estimated in its own site-specific environmental analysis.

Figure I–2
Environmental Analysis, Documentation, and Implementation of "The NEPA Process"



Where the impacts found are not significant, this analysis will be documented in an environmental assessment. Where the activity is routine and has minor impacts (and is listed in the categories in Forest Service Manual 1952.2), the environmental analysis may be "categorically excluded" from documentation. Where site-specific environmental analysis shows that an activity may have significant impacts, however, an environmental impact statement will be prepared.

Ties to Forest Plans

The Forest Service has an extensive, three-level planning process for the management of land and resources of the National Forests. In addition to 1) the Forest Plans now being developed for each National Forest in the Region, there is 2) a Regional Guide for the Pacific Northwest Region (1984), and 3) national guidance in the Resources Planning Act (RPA) Programs (1980 and 1985). The information and direction developed at each level is based on the information and direction in the other levels.

The Forest Plans are based on extensive analysis of resource capability, environmental effects, and economic factors. They designate parts of the Forests to different mixes of uses; schedule activities; determine appropriate levels of production; and establish standards and guidelines to safeguard environmental quality and long-term productivity for each National Forest.

Vegetation Management and Forest Plans

Projects that manage unwanted and competing vegetation help accomplish the goals and meet the standards established by the Forest Plans.

This environmental impact statement (EIS) looks at those vegetation management projects collectively as a program, and analyzes and discloses their environmental impacts. In addition, it presents their implications for the cost and amount of work needed to manage the Forests.

Analysis and choices made in the Forest planning process are based on detailed data and familiarity with local conditions. While this EIS does display the Regionwide management implications of the alternatives, it does not specifically change any allocation or expected output level in the Forest Plans.

Decisions based on this EIS could affect the Forest Plans. The Forest Plans were developed using the assumption that all methods of managing vegetation would be available.

If the new vegetation management procedures and mitigation measures would change the decisions made on the way lands and resources would be managed on a National Forest, then changes in the Forest Plan will be needed.

These changes can be analyzed and presented in different ways, depending on the stage of development of each Forest Plan. Changes can be: 1) included in a reissued draft Forest Plan (accompanied by its revised draft EIS); 2) incorporated in the Forest Plan (and its final EIS); or 3) made by amendments to Forest Plans already in effect.

The information in this EIS was designed to enable the Regional Forester to select a vegetation management program for the Region. Cost, environmental effects, and production implications will be part of that information. That decision does not specifically change the Forest Plans. However, Forest Supervisors and their planning teams must evaluate the effect of the new vegetation management procedures on their own Plan, and make revisions as needed.

Major Legislation Relating to This EIS

- The National Environmental Policy Act of 1969 (as Amended) (NEPA)
- Federal Environment Pesticide Control Act of 1972 (FEPCA)
- Federal Pesticide Act of 1978 amending the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
- Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA)
- The National Forest Management Act of 1976 (NFMA)
- Environmental Quality Improvement Act of 1970
- The Clean Air Act (Section 309)
- The Water Quality Act of 1987
- The Safe Drinking Water Act

Summary

Managing competing and unwanted vegetation in the Region is a large program that has the potential for significant environmental consequences. During the scoping, continuing involvement, and formal comment periods, the public has demonstrated continuing interest in, and concern about, the program and its related major issues. They have also demonstrated active interest in evaluating alternative ways of managing competing and unwanted vegetation, and the environmental consequences of those alternatives. This EIS responds to those issues.

Chapter II

The Alternatives

Chapter II

What Reviewers Said	Our Response
People suggested that we should:	
1. Re-examine the relationship between long-term sustained yield and allowable sale quantity. Some felt that a Forest-by-Forest examination would be the most desirable way to calculate the quantity and PNV implications of the alternatives.	1. We developed Forest-by-Forest Allowable Sale Quantities and have included them in the FEIS. They are used in calculations for jobs and payments to local governments.
2. Explain the reason for a floating budget, particularly with regard to Alternatives A and D.	2. We now explain the "floating budget" concept in developing Forest data.
3. Include economic effects of various taxes.	3. Regulations relating to the National Environmental Policy Act recommend not including the effects of taxes in analysis. We have cited this reference in the text.
4. Use a different demand curve.	4. We used the same curve, but material on demand functions and real price trends has been added to the section on Comparing the Cost/Benefit Dimension of the Alternatives.
5. Change stream buffer widths. (Some respondents wanted them smaller, some wanted them larger.)	5. Rather than change and rely on a single buffer width, we added a mitigation measure that requires site specific analysis to set buffer widths for herbicide application projects .
6. Clarify the logic for the extrapolation of growth and yield effects data to make a region-wide estimate.	6. A discussion of extrapolation methodology is included in the Comparing the Alternatives section under Comparing the Effectiveness of Techniques Dimension of the Alternatives.

What Reviewers Said	Our Response
7. Describe existing silvicultural efforts to incorporate preventive strategies and the use of natural systems to deal with competing vegetation.	7. We cover this subject in the Five Steps in Managing Unwanted and Competing Vegetation section.
8. Include a monitoring plan in enough detail to show how management objectives, mitigation measures, and targets can be achieved over time.	8. We expanded the monitoring plan in this chapter .
9. Define the term "last option".	9. We wanted public response to help us develop a policy for use of herbicides in our preferred alternative. Our preferred alternative states that herbicides will be used only when necessary: when other tools won't get the job done or would have unreasonable costs.
10. Explain the "risk indices" for herbicides and smoke used in Chapter II.	10. The risk indices were confusing. We do need a way to compare risks between alternatives. Since no absolute measure is possible, we now use acres treated by method as a relative indication of health risk.

Chapter II

The Alternatives

The alternatives are the heart of an EIS. Once the issues are characterized, alternative ways of resolving the issues and resource management needs become the focus of the environmental analysis process. The environmental consequences and management implications of the different alternatives are analyzed, evaluated, and compared. This forms the basis for an informed decision on which course of action to follow.

All of the material pertaining to the alternatives is here, or is summarized here, in this chapter. It is a large chapter, and a complex one.

How This Chapter Is Organized

Alternative Descriptions. First the alternatives are described. The description of each alternative presents the methods, tools, and process that would be used in managing competing and unwanted vegetation if that alternative were selected.

Alternative Comparisons. The environmental consequences and the management implications of the alternatives are compared to each other. These comparisons are organized around the seven issues identified in Chapter I. Much of the information for the comparisons comes from Chapter IV.

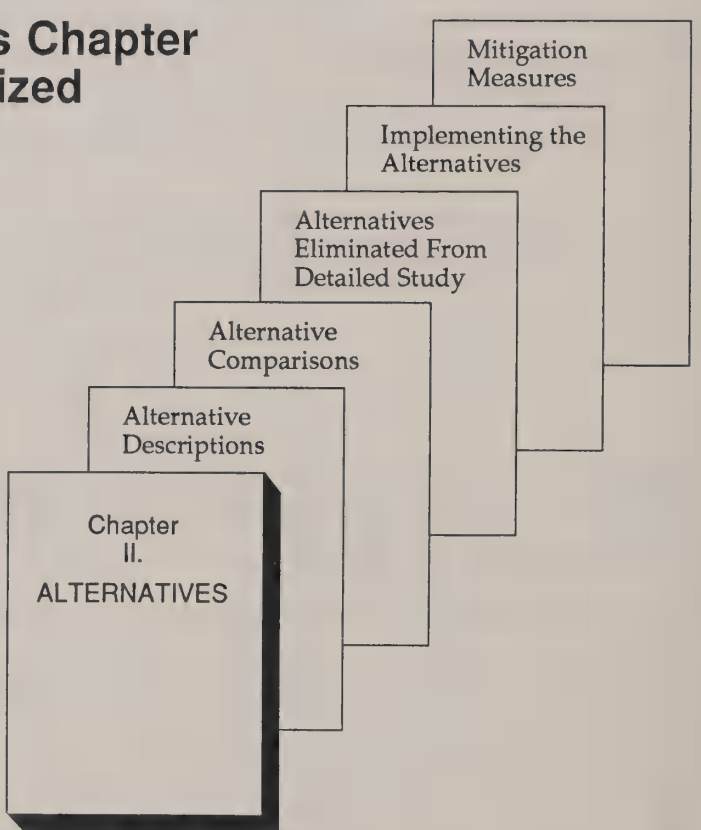
Alternatives Eliminated from Detailed Study. This short section describes several alternatives that were considered, but were not analyzed in as much detail as the principal alternatives.

Implementing the Alternatives. This section expands on the steps that will be involved in managing competing and unwanted vegetation in the field, for all alternatives. It explains the tie between the required site-specific environmental analysis and the special emphases for vegetation management projects.

Mitigation Measures. The final section of this chapter presents the special measures that will be used to avoid or minimize the potential environmental impacts of managing competing and unwanted vegetation.

Figure II–1

How This Chapter is Organized



Chapter 2
The Alternatives

Description of the Alternatives

Description of the Alternatives

This section begins with a brief introduction to the alternatives, followed by Figure II-2, a two-page overview of the alternatives. Then, the methods, tools, and operation of each alternative is described.

A Program EIS

This Environmental Impact Statement (EIS) is a "program EIS", disclosing the environmental effects of a program that may have hundreds of specific projects. The alternatives here present different ways of managing competing and unwanted vegetation on all National Forests in the Region.

The alternatives provide different instructions to the people analyzing, designing, and carrying out vegetation management in the Region. The alternatives differ in the kind and degree of instruction given.

All the alternatives require a site-specific analysis of the vegetation management situation before work starts, as well as an environmental analysis to explore options and to discover the environmental consequences of the proposed project. All alternatives assure the public of information about vegetation management projects.

The resource management philosophy of all the action alternatives is to intensively manage resources, meet Forest Service program goals, and to have minimal adverse effects on the environment.

Figure II–2

Overview of the Alternatives

Alternatives	A	B	C	D
Manages Competing and Unwanted Vegetation	...with no herbicides.	...with all effective tools.	...rarely, and and only for human safety.	...emphasizing prevention and the use of natural processes.
Time for Action	At first sign before damage occurs	At first sign before damage occurs.	No action unless vegetation threatens public safety.	At first clear sign of potentially significant damage.
Project Design	*Prevention and correction both o.k.; herbicides will not be used.	Prevention and correction both o.k.; all tools and methods available.	Correction only; fire and herbicides both prohibited.	Prevention is preferred; herbicides available as a last option.

** "Prevention" and "correction" are two strategies for managing vegetation. Successful prevention keeps vegetation problems from getting to the point where they require correction.*

*** Forest Service preferred alternative..*

E	F	G	H **
...with restricted use of herbicides and special worker safety.	...with no burning for silviculture.	...aggressively, with all tools.	...with all tools. Non-herbicide methods preferred. Using special herbicides requires special consideration.
At first sign, before significant damage occurs.	At first sign, before damage occurs.	At first sign, before damage occurs.	Evaluate early stages of main project. Act when evidence suggests growth loss or significant damage will occur.
Prevention is preferred; some herbicides prohibited, no aerial application; manual use restricted.	Prevention and correction o.k.; fire will not be used to prepare planting sites.	Prevention and correction o.k.; all tools and methods freely available.	Prevention is emphasized. Reduce reliance on herbicides, and prescribed fire for treatment of slash. Three herbicides prohibited.

Alternative A

Purpose and Theme

This alternative is designed to eliminate all risk associated with the use of herbicides in managing competing and unwanted vegetation. Other effective and efficient techniques are to be used.

Alternative A approximates the current vegetation management program, carried into the future. Herbicides are not currently available as a management tool, due to a judgement which was entered March 14, 1984, which found that, "The defend[a]nts have not prepared an adequate Worst Case Analysis, pursuant to their NEPA obligations." An injunction against the use of herbicides in the Pacific Northwest Region of the Forest Service and Bureau of Land Management Districts in the State of Oregon was issued, to be in effect until agency obligations were fulfilled.

Alternative A is a "no action" alternative in that it represents the current situation–including the injunction–carried into the future. Alternatives B and C can also be viewed as "no action" alternatives.

Time for Action

The need for action is evaluated at the first sign of any competing or unwanted vegetation that could potentially damage wanted species or desired conditions. The intent is to eliminate or reduce competition or hazards before there is damage to wanted species or conditions. For example, the presence of seeds and proper conditions for germination of snowbrush ceanothus on a newly harvested unit may trigger an evaluation of the need for control.

If information is incomplete about specific damage relationships or the effectiveness of methods on a specific site, the manager should act to assure that program goals are met (even if a "wait and see" approach might eventually reveal minimal damage or more efficient methods). Regardless of whether control is applied, monitoring and evaluation are essential.

Project Design

The factors to consider in designing projects are as follows:

Strategy: The most appropriate strategy for a given situation will be implemented, with no predisposition toward either prevention or correction.

Human Health Risk: As in all alternatives, the potential for risk to human health is of concern in selecting a vegetation management technique. Under this alternative, avoiding herbicides eliminates any risk associated with them, while increasing risks from substitute methods. All techniques being considered will be analyzed for potential direct and indirect effects on human health prior to action. The selected technique will have low risk when compared to other suitable techniques that also meet other design criteria.

Environmental Effects: Most adverse effects in both the long and short-term will be minimized by following the appropriate land management documents, and additional mitigation measures described in this EIS. These documents specifically address diversity, long-term productivity, and ecosystem functions on a site-specific basis. In the face of uncertainty concerning effects of a particular tool, the manager will balance the potential for an adverse environmental impact with cost and benefits.

Tools Available: The use of herbicides to control competing and unwanted vegetation is prohibited; all other tools and techniques are permitted.

The use of tools has and will continue to change, based on new research, the analysis of completed projects, improvements in technology, and public need. To minimize environmental effects and sustain long-term productivity, National Forest managers are continuing to evaluate tools and intensity of application.

Budget and Costs: The costs of the activities will vary, but will generally not exceed budgets that can be reasonably expected.

Outputs: Vegetation management activities will be those required to support the production of Forest commodities at a level approximating those of the applicable land and resource management plans.

Alternative B

Purpose and Theme

All effective and efficient techniques for managing competing and unwanted vegetation are available, consistent with the direction provided in applicable land and resource management plans.

The management of competing and unwanted vegetation specified in this alternative approximates the direction for vegetation management contained in current and proposed Forest Plans. The fiscal year 1989 program serves as the reference for budgets, outputs, and vegetation management activities for all alternatives.

Alternative B is also a "no action" alternative in that it represents the current situation–not including the injunction against the use of herbicides–carried into the future. Alternatives A and C are also "no action" alternatives.

Time for Action

The need for action is evaluated at the first sign of any competing or unwanted vegetation that could potentially damage wanted species or desired conditions. The intent is to eliminate or reduce competition or hazards before there is damage to wanted species or conditions. For example, minimizing soil disturbance in an area where noxious weeds are likely to invade, or timely planting or seeding of roadsides with low herbs and shrubs, reduces the need for vegetation control activities.

If information is incomplete about specific damage relationships or effectiveness of methods on a specific site, the manager should act to assure that program goals are met (even if a "wait and see" approach might eventually reveal minimal damage or more efficient methods). However, monitoring of results is essential to assess the method and fine tune future applications.

Project Design

The factors to consider in designing projects:

Strategy: The most appropriate strategy for a given situation will be implemented, with no predisposition toward either prevention or correction.

Human Health Risk: Methods will be analyzed for risk to human health and safety prior to use. Results will be monitored and records

will be reviewed and analyzed to evaluate health effects on all methods. Mitigation measures, if needed, will be incorporated into project design to minimize potential impacts on human health. Chemicals approved by the EPA are acceptable after Forest Service review.

Environmental Effects: Adverse effects in both the long- and short-term will be minimized by following the appropriate land management planning documents, and by additional mitigation measures described in this EIS. These documents specifically address diversity, long-term productivity, and ecosystem functions on a site-specific basis. In the face of uncertainty concerning effects of a particular tool, the manager will balance the potential for an adverse environmental impact with cost.

Tools Available: All tools and techniques are permitted. The use of tools has and will continue to change, based on new research, the analysis of completed projects, improvements in technology, and public need. To minimize environmental effects and sustain long-term productivity, National Forest managers are continuing to evaluate tools and intensity of application. Opportunities to reduce the use of herbicides will be sought.

Budget and Costs: Projects to manage unwanted vegetation will not exceed the FY 1989 Forest program budget. The methods selected will be the most cost-efficient means to meet the management objectives.

Outputs: Vegetation management activities will be those required to support the production of Forest commodities at a level approximating those of the applicable land and resource management plans.

Alternative C

Purpose and Theme

The vegetation management approach here is one of "no action" unless public safety is clearly and directly threatened. For example, hazard trees will be removed from campgrounds, and roadside brushing will be done to maintain safe travel, but virtually all of the vegetation management normally associated with forest management will not be done. Some resource production objectives may not be met.

There is virtually no active intervention to manage competing and unwanted vegetation in Alternative C. Only situations that pose a direct threat to public safety will trigger action to suppress unwanted vegetation; and in these cases, neither herbicides nor fire will be used.

This alternative is the "no action" alternative required by regulation (40 CFR 1502.14). This alternative is "no action" in the sense that it shows what would happen if we took no actions to manage competing and unwanted vegetation. While it serves an important analytic role, it is also an alternative that could be implemented if it were selected. However, it is a dramatic departure from the manner in which the Forests have historically been managed. Alternatives A and B can also be viewed as no action alternatives.

Public involvement will occur infrequently, primarily because of little or no vegetation management activities. If a vegetation management project is proposed, NEPA guidelines will guide the public involvement efforts.

Time for Action

Action will not occur unless there is a direct threat to public safety. While little active intervention occurs, there will still be some management of unwanted vegetation.

Because of the nature of this alternative, Forests are expected to have no vegetation management in the following activity areas:

- site preparation and release;
- tree genetics support activities;
- research;
- range improvement;
- noxious weed control;

- wildlife habitat improvement; and
- prescribed burning.

Project Design

The factors to consider in designing projects include:

Strategy: No action will be taken until the vegetation is clearly identified as a direct threat to public safety. Correction, as opposed to prevention or maintenance, will be the most common approach.

Human Health Risk: Health risks associated with methods of treating vegetation will be eliminated, except for the occasional case where vegetation management is used to eliminate a direct threat to public safety.

Environmental Effects: Existing Federal laws and regulations will be met; however, compliance at the state level with state regulations and the state Forest Practices Act may not occur.

Tools Available: Chemical techniques and fire are both prohibited. All other tools and techniques are permitted as necessary.

Budget and Costs: The method with minimal initial cost will be utilized. Only fuel treatment which removes a direct threat to public safety (such as fuel management in inhabited sites) will be done.

Outputs: There are likely to be changes in outputs from those stated in the applicable land and resource management plans.

Alternative D

Purpose and Theme

The key to this alternative is the integration of natural ecosystem processes into managing competing and unwanted vegetation. Here, vegetation management emphasizes the implementation of the philosophy of having the least impact on the natural environment while producing products and amenities for human use.

The implementation of the alternative will involve early preventive measures, monitoring of sites, and frequent evaluations of conditions and practices. Vegetation is managed to avoid the need for corrective measures; however, correction, if needed, is done in a way to least alter natural ecosystems and processes. It requires the consideration of the health of those ecosystems as seen in conditions such as growth and diversity.

This alternative places an increased emphasis on early involvement of the public in environmental analysis procedures, and on carrying this participation through to project implementation and monitoring.

Time for Action

Action is called for at the first clear sign of potentially significant damage from unwanted vegetation. The project planning stage is the most appropriate stage for implementing a prevention strategy. For example, site analysis may identify a plant association known for its potential to compete with crop trees. The harvest prescription may then include measures to limit the vigor of competing vegetation. The result may lessen the need for subsequent corrective action (in this case, release) and result in lower overall costs. Action will be taken when conclusive evidence—or documented local experience, such as site-specific surveys—indicates that significant damage or growth loss will occur.

Project Design

The factors to consider in designing projects include:

Strategy: Prevention is the preferred strategy for pre-empting vegetation problems. Intervention with corrective measures will be used if preventive measures alone are infeasible, inappropriate, or when unacceptable vegetative conditions have resulted from the design and execution of projects prior to the adoption of this EIS.

Human Health Risks: Minimizing human health risks is important

in selecting techniques. All techniques will be analyzed for risks prior to action. The selected technique will have low risk when compared to other suitable techniques which meet other design criteria. Mitigation measures, if needed, will be incorporated into project design to minimize potential impacts on human health.

Environmental Effects: Minimizing adverse environmental effects is also important in selecting techniques. As with other alternatives, the potential environmental effects will be fully explored before taking action that may adversely affect long-term productivity or the diversity and integrity of the natural ecosystem. In the face of uncertainty, the manager will select a technique that minimizes potential adverse effects on ecosystem structure and function.

Tools Available: The preferred tools are those which prevent damage from unwanted or competing vegetation through the design and execution of silvicultural, construction, and other resource management projects to avoid creating or intensifying problem vegetation.

As a result, corrective action, which corrects a problem once the competing or unwanted vegetation is already well established, is not needed as much as in the past. Generally, corrective actions include slash disposal, suppression of competing vegetation for planting or release, spraying or brushing rights-of-way, and suppression of noxious weeds. Although these actions are usually considered corrective, it is the intensity, frequency, extent, and timing of their implementation that sometimes distinguishes a corrective action from a preventive action (refer to the section in this chapter that discusses the five steps in managing vegetation for definitions and examples of corrective and preventive actions).

Specifically, the Forests' use of a prevention strategy to control unwanted and competing vegetation may result in a reduction—ranging from 30 to 60 percent Regionally—of acreage historically treated with a corrective action in the last five years (1981-1985). (For herbicide use, the five-year period prior to the 1984 injunction is used.)

In the Coastal Forests, a higher percentage of the acreage may need corrective treatment, although an overall reduction of treatment need is expected. The East-side Forests, on the other hand, may experience a greater overall reduction in treatment needs, and a higher than average reduction in corrective activities. Most important, preventive actions will tend to increase over time, and corrective actions will decrease.

Herbicides are available under this alternative, but will be the last option considered. "Last option" means that all other methods would be preferred to using herbicides. These other methods would be used unless they were impractical or would generate unreasonable costs. Herbicide use is expected to be reduced significantly (ranging from 40 to 70 percent from the historic five year period). Some programs will require a gradual reduction. Road maintenance, for example, must work with a road system developed under a different strategy. Conversion will be costly and require a cautious approach, learning as feedback is accumulated and analyzed.

As market opportunities allow, utilization of logging slash will be encouraged, to reduce the total on-site tonnage burned. (Fifty percent or less of the average historic acres will be treated.) Prescribed fire is available in conjunction with specific determination of site conditions and probable post-burn vegetation response. The need for coarse woody debris for long-term site productivity is recognized.

Budget and Costs: The costs of the activities will vary, but will generally not exceed budgets which can be reasonably expected.

Outputs: Vegetation management activities will be those required to support the production of Forest commodities at a level approximating those of the applicable land and resource management plans.

Alternative E

Purpose and Theme

This alternative is designed to reduce the risks of herbicide use to the public, and to reduce the risk of herbicide use and manual vegetation treatments to forest workers. No aerial application of herbicides is permitted; specific herbicides are prohibited; and additional safety requirements for workers are imposed.

Time for Action

Action would be taken when significant damage, or the clear potential for such damage, occurs to a desired species or vegetative system.

If complete information is lacking as to a specific damage relationship or the effectiveness of methods on a specific site, the manager will take an approach that assures protection of human health. For example, yarding of logging slash may be preferred over burning in an area where smoke is likely to accumulate in populated areas.

Project Design

The factors to consider in designing projects include:

Strategy: Prevention is the preferred strategy, except where correction is either the only feasible approach, or can be shown to incur lower cost or environmental impacts.

Human Health Risk: This is the major concern and driving force in selecting a vegetation management technique. The potential for direct and indirect health effects will be analyzed before taking any action that might pose a risk to human health. The selected technique will pose the lowest risk to human health.

Environmental Effects: Adverse effects in both the long- and short- term will be minimized by following the appropriate land management planning documents and any additional mitigation measures described in this EIS. These documents specifically address diversity, long-term productivity, and ecosystem functions on a site-specific basis. In the face of uncertainty concerning effects of a particular tool, the manager will balance the potential for an adverse environmental impact with cost.

Tools Available: All tools and techniques are available with the following exceptions:

- 2,4-D, amitrole, diuron, and fosamine will not be used in any application.
- Backpack and ground applications of herbicides may be used, but there will be no aerial applications. Bromacil, 2,4-DP, and simazine will not be used in backpack spray applications.
- Other Forest Service-reviewed herbicides may be applied using backpack spray techniques only after completion of training beyond the standard certification training for all workers. Applications will be limited to brush of a more restrictive, specified height and density.
- The use of power tools will require operator safety training and proper protective gear, and will not be used in brush that is too high or dense for safe operation. This is not meant to preclude hand-construction of firelines in emergencies.
- Burning of herbicide-treated vegetation is prohibited. Use of chemicals in watersheds formally designated as municipal or industrial watersheds is prohibited. Residue utilization will be a priority before burning of slash can be considered. However, prescribed burning is fully available for treating natural fuels.

Budget and Costs: The costs of the activities will vary, but will generally not exceed budgets which can be reasonably expected.

Outputs: The vegetation management activities will be those required to support the production of Forest commodities at a level approximating those expected in applicable land and resource plans.

Alternative F

Purpose and Theme

This alternative is designed to manage competing and unwanted vegetation without the use of prescribed fire for silvicultural purposes. All other effective and efficient techniques of vegetation management are available.

The burning of logging slash would be allowed only to reduce wildfire hazard. Residue utilization would be encouraged in place of burning, and burning of chemically treated vegetation would be prohibited.

Time for Action

Action is called for at the first sign of any competing or unwanted vegetation that could potentially damage wanted species or desired conditions. The intent is to eliminate or reduce competition or hazards before there is damage to wanted species or conditions.

If information is incomplete about specific damage relationships or the effectiveness of methods on a specific site, the manager acts to assure that program goals are met (even if a "wait and see" approach might eventually reveal minimal damage or more efficient methods).

Project Design

The factors to consider in designing projects include:

Strategy: The most appropriate strategy for a given situation would be implemented, with no predisposition toward either prevention or correction.

Human Health Risk: The potential for risk to human health is of concern in selecting a vegetation management technique. All techniques being considered will be analyzed for risk prior to action. The selected technique will meet other design criteria and have a low risk to human health.

Environmental Effects: Adverse effects in both the long- and short-term will be minimized by following the appropriate land management planning documents, and additional mitigation measures described in this EIS. These documents specifically address diversity, long-term productivity, and ecosystem functions on a site-specific basis. In the face of uncertainty concerning effects of a particular tool, the manager will balance the potential for an adverse environmental impact with cost.

Tools Available: Prescribed fire will not be used to treat logging slash for site preparation. Burning of logging slash will be allowed only for protection purposes, and then only if no other vegetation management tool will achieve the same hazard reduction. The Fuel Appraisal Process will be used to determine whether or not slash will be treated to reduce wildfire hazard. Prescribed fire may be used for treating natural fuel accumulations for reducing wildfire hazard, wildlife habitat improvement, and range improvement.

Use of chemicals that are approved by the EPA for controlling competing and unwanted vegetation will be allowed after Forest Service review. Burning of chemically treated vegetation will be prohibited.

Budget and Costs: The costs of the activities will vary, but will generally not exceed budgets which can be reasonably expected.

Outputs: The vegetation management activities will be those required to support the production of Forest commodities at a level approximating those expected in the applicable land and resource management plans.

Alternative G

Purpose and Theme

This alternative manages competing and unwanted vegetation aggressively, to maximize production of resources for human use. All techniques for managing vegetation are available.

Time for Action

Action is called for at the first sign of any competing or unwanted vegetation that could potentially damage wanted species or desired conditions. The intent is to eliminate or reduce competition or hazards before there is any damage to wanted species or significant reduction in growth or outputs.

If information is incomplete about specific damage relationships or effectiveness of methods on a specific site, the manager should act to assure that program goals are met or exceeded (even if a "wait and see" approach might eventually reveal minimal damage or more efficient methods). Site preparation, release activities, and noxious weed control activities are consistently applied to maximize early growth and production of forage.

Project Design

The factors to consider in designing projects include:

Strategy: The most appropriate strategy for a given situation will be implemented, with no predisposition toward either prevention or correction.

Human Health Risk: Methods will be analyzed for risk to human health and safety prior to use. Mitigation measures, if needed, will be incorporated into project design to minimize potential impacts on human health. Chemicals approved by the EPA are acceptable after Forest Service review.

Environmental Effects: Adverse effects in both the long- and short-term will be minimized by following the appropriate land management planning documents, and additional mitigation measures described in this EIS. In the face of uncertainty concerning effects of a particular tool, the manager will balance the potential for an adverse environmental impact with the benefits of increased resource production.

Tools Available: All tools and techniques are available to the

Forest manager. The use of tools has and will continue to change, based on new research, the analysis of completed projects, improvements in technology, and public need. To minimize environmental effects and sustain long-term productivity, National Forest managers will continue to evaluate tools and intensity of application.

Budget and Costs: Projects to manage unwanted vegetation may exceed the fiscal year 1989 Forest program budget.

Outputs: Vegetation management methods will be used to attempt to exceed the anticipated Forest commodity production levels in the applicable land and resource management plans. Commodity production should not drop below those levels projected for the years after the current Forest Plan.

Alternative H

Purpose and Theme

The purpose of this alternative is to conduct a Regional vegetation management program so that it 1) protects human health, 2) promotes long-term health and productivity of forest ecosystems, and 3) meets the goals and objectives of land management plans.

The theme here is to reduce the reliance on herbicides, to continue to reduce the use of fire for treating slash, and to support providing goods and services at high levels.

To achieve its purposes and theme, this alternative emphasizes preventing vegetation management problems. All methods for managing competing and unwanted vegetation will be available. Protecting rural communities and wildernesses from the deleterious effects of smoke is a high priority. This alternative also requires early involvement of the public to help set project goals, conduct environmental analysis, observe project implementation, and to monitor the results of projects.

Time for Action

The intent of this alternative is to detect and resolve vegetation management problems before they cause serious losses or require large correction projects. This calls for evaluating the need for action when problems are expected. The evaluation should include site-specific surveys and documented local experience. Then, when the evaluations verify that the expected problems are likely to occur, action will be taken. This approach will help managers to detect and control vegetation problems before they cause damage.

At times, results of the evaluation may be inconclusive and managers won't be sure that serious damage will occur. Managers may then elect to defer action until it is clear that a problem is developing. In some cases, waiting may reveal that the damage is minimal and that further action is not needed.

Project Design

The factors to consider in designing projects include:

Strategy: This approach emphasizes the use of prevention and natural processes to manage competing and unwanted vegetation. It requires creative solutions that use the biological and technical knowledge gained through monitoring. Managers will need to anticipate

potential vegetation management problems and take steps to avoid them. When corrective measures are needed, those projects should be designed to move toward preventive strategies.

The planning stage for any project (such as timber harvest, road construction or range improvement) is the most appropriate time for implementing a prevention strategy. For example, the site analysis may identify a plant association known for its potential to compete with crop trees. A harvest prescription may then include measures to limit the vigor of competing vegetation, be designed to reduce the need for subsequent corrective action (in this case, release), and result in lower overall costs.

Human Health Risks: The evaluation of human health risks, including exposure to hazardous substances and injuries, is an important factor in designing projects and in selecting vegetation management methods. All methods that are being considered will be analyzed prior to use for potential direct and indirect effects on human health. Herbicides and prescribed fire for slash treatment associated with reforestation will be used only when necessary. Selected methods will present low risk when compared to other methods that could also meet the design criteria.

The protection of recreational and rural residential populations from exposure to smoke from forestry burning will be given special attention. All practicable means of smoke management (reduction, avoidance, and scheduling) will be employed.

Environmental Effects: Adverse effects will be minimized by using 1) site-specific environmental assessments, 2) mitigation measures described in this EIS, and 3) natural processes. The site-specific environmental assessments will address potential environmental effects for proposed projects. They will also help identify project designs and mitigation measures that will be necessary to minimize adverse effects. The diversity and integrity of the natural ecosystem and long-term productivity are major considerations in this process.

Tools Available: This alternative makes all tools available while working toward the goal of reducing reliance on herbicides. Using herbicides requires special considerations to establish their need, assess the risks, and to implement special mitigation measures. Herbicides will be used only when necessary; that is, when other methods would not be effective, or their costs would be unreasonable. As a part of the site-specific NEPA process, the responsible officials will document the criteria they used in establishing the need for using herbicides.

Vegetation that has been treated with herbicides will not be burned within one year of application, and utilizing management activity-generated residues is preferred to burning. However, prescribed burning is available, often being the preferred method for reducing the natural accumulation of dead plant debris, maintaining ecosystems at a more productive stage of succession, and regenerating decadent, fire-dependent plant communities.

Two of the herbicides evaluated for use, diuron and fosamine, had insufficient data to support toxicological analysis. A third herbicide, amitrole, poses unaccaptable cancer risks under normal exposure scenarios. None of the three herbicides will be used under this alternative.

The use of all tools and methods requires operator safety training and proper protective gear. The Forest Service will coordinate vegetation management activities with its neighbors. In addition, all contracts will provide for worker education and safety, including the use of protective clothing, at a level equivalent to that specified for Forest Service employees.

Forest managers will continue to evaluate and monitor tools and intensity of application. Methods used will continue to change based on new research, analysis of completed projects, improvements in technology, and public need.

Budget and Costs: The costs of the activities will vary, but will be within the budgets that can be reasonably expected. In selecting vegetation management methods for projects, human health risks, environmental effects, project-specific decision criteria, and cost-efficiency will be considered.

Outputs: Vegetation management activities will be those required to support the production of forest goods and services at a level approximating those of the applicable land and resource management plans.

The Preferred Alternative

Alternative H is the preferred alternative identified in this final EIS.

Regulations require the EIS to "identify the agency's preferred alternative or alternatives, if one or more exists, in a draft statement and identify such alternative in the final statement." (40 CFR 1502.14(e)).

The "Draft Preferred" Alternatives: Alternatives B, D, and E were evaluated and recommended by the interdisciplinary team as the Forest Service's "preferred alternatives" in the draft EIS. The Regional Forester reviewed that recommendation with his staff and selected these alternatives as the preferred alternatives for the draft EIS.

The "Final Preferred" Alternative: After the public, other resource professionals, and scientists reviewed the draft during a formal comment period, the team met to analyze their comments and respond to them. One key part of that response was development of Alternative H.

All four alternatives, B, D, E, and H, would permit the Forest Service to fulfill its statutory mission and responsibilities, considering economic, environmental, and technical factors. All four also respond to the range of issues. One key response to issues was the development of Alternative H, which was built from the preferred atlernatives identified in the DEIS and public comments received on the DEIS.

Chapter 2
The Alternatives

Comparing the Alternatives

Comparing the Alternatives

One of the most interesting and revealing sections in an environmental impact statement is the comparison of alternatives. The comparison highlights similarities and differences between alternatives and strives to give readers a better understanding of each scenario. It allows the reader to begin differentiating between alternatives and deciding which one best meets their ideas, concerns, and issues.

We encourage you to refer to this section often as you read, think about, and comment on other parts of this EIS.

This section compares alternatives by presenting:

- an overview of how alternatives respond to issues (Figure II-3);
- a detailed narrative comparison of alternatives by issue; and
- a series of tables that estimate effects and suggest implications for each alternative.Insert II-3

Comparing the Human Health Dimensions of the Alternatives

Each of the alternatives has a potential for impacts on the health of both forest workers and the general public. The risk of health impacts is much greater for forest workers because they are subjected to repeated and more direct exposure to risk factors. Health risks to the general public are liable to be experienced primarily through exposures to herbicides or smoke that have been transported away from a project area by wind or water.

For this analysis, risks and effects are estimated only for those activities directly associated with vegetation management. The comparison includes analysis of:

- Injuries from manual control of vegetation and brush;
- Injuries from the management and control of prescribed fires and wildfires:
- Health effects from exposure to smoke from prescribed fires and wildfires; and
- Health effects from exposure to herbicides used to manage vegetation.

The analysis does not include risks from activities that are inciden-

Table II-1

Thousands of Acres Treated Yearly by Method and Alternative

	Alternative							
Method	A	B	C	D	E	F	G	H
Herbicide	0	59.9	0	26.8	47.9	64.1	76.6	51.5
Mechanical	184.6	167.2	44.9	111.6	166.9	201.0	155.6	162.0
Manual	99.0	77.8	17.7	57.8	95.1	80.1	85.7	79.7
Biological	14.8	.3	3.8	18.7	5.9	8.3	6.9	7.4
Fire	217.8	210.0	0	125.8	194.0	175.8	215.0	202.0
No treatment	24.4	19.9	15.6	23.8	24.1	36.1	21.53	31.8
Other	11.5	14.1	4.8	16.0	14.7	11.0	18.3	8.8
Total	552.1	553.0	86.8	380.5	548.6	566.4	579.63	543.2

Table II-2

Anticipated Number of Worker Accidents Per Year
(from combined use of manual methods and prescribed burning, by alternative)

	Alternative							
	A	B	C	D	E	F	G	H
Minor injuries	1,25O	1,053	189	741	1,152	1,004	1,126	1,017
Major injuries	30	29	3	19	27	25	30	26

tal to vegetation management, such as transportation to job sites, and exposure to gasoline, exhaust fumes, and noise from engines (chain saws, tractors, helicopters, etc.). Although the risks from these exposures are real, there are far too many to cover them adequately in this analysis.

Comparison of Risks Among Alternatives

Table II-1 shows the acres treated by each method for the eight alternatives. Comparisons that can be made by alternative using the acres treated in table 4-2 include: 1) estimated number of worker accidents, and 2) risk to workers and public from herbicides and smoke.

Only forest workers, and not the public, are expected to be at risk from immediate injury from accidents. The risk of injury occurs primarily with the use of manual Table II-1 methods or prescribed fire on rough terrain. The difference in risks between alternatives can simply be estimated from the total numbers of acres that receive manual or fire treatment in an alternative.

In this analysis, the number of injuries is estimated as follows. Minor injuries are expected to occur in prescribed fire treatments at the rate of two for every 1,000 acres treated. For manual methods, the estimated rate is 7.7 per 1,000 acres treated. For major injuries, the estimates are made only for prescribed fire treatments and are expected to occur at the rate of 0.13 per 1,000 acres treated.

Using the acre estimates from Table II-1 and the accident rates discussed above, the risks from using manual methods and prescribed fire can be compared among alternatives (Table II-2).

There are risks to both forest workers and the general public from exposure to herbicides and smoke. The difference in risks can be determined by comparing the numbers of acres in each alternative that would be treated with herbicides or would be burned by prescribed fire. The analysis does not try to estimate the actual number of people that might be affected by these exposures, because it would have to rely on too many disputed assumptions.

Summary Description of Alternative Health Effects

The human health risks of the program alternatives are compared in Table II-3 and summarized here. Alternative A prohibits the use of herbicides. It has a large decrease in acres treated with herbicides and smaller increases in prescribed fire, manual, mechanical, and biological methods. Some problems with adverse health effects from noxious weeds may occur. Under Alternative B, all methods of vegetation management are available consistent with the direction given in

Table II-3

Summary of Health Risks of Alternatives

Alternative	Manual Methods	Mechanical Methods	Prescribed Burning
A No herbicides	Highest risk alternative for injuries	Highest risk alternative for injuries	Highest risk alternative for injuries
B Current Management	633 major injuries 20 minor injuries	At lease 4 minor injuries workers & public	420 minor injuries smoke effects to
C No Action	Lowest effects	Lowest effects	Lowest effects
D Least Management	About half the injuries of Alternative B.	About half the injuries of Alternative B.	About half the injuries of Alternative B.
E No Aerial Spray	About the same as Alternative B.	About the same as Alternative B.	About the same as Alternative B.
F Reduced Fire	Slightly increased risk over Alternative B.	Significantly increased risk over Alternative B.	Reduced risk of injury and chronic effects.
G Increase Management	Slightly increased risk over Alternative B.	Slightly lower risk than Alternative B.	Risks about the same as Alternative B.
H Preferred	Slightly increased risk over Alternative B.	Slightly lower risk than Alternative B.	Slightly lower risk than AlternativeB.

Biological Methods	Herbicides	Overall
High acreage could result in some risk	No Effects	Injury risk high; chronic risk very low.
Minimal risk of waterborne disease	Acute effects: risk in spills only; long term effects: risks to workers and public.	Injury risk high; chronic risk very low.
Lowest effects	No effects	Lowest program risk.
High acreage could result in some level of disease risk.	No effects	Lowest risks of all management alternatives except "no action".
Minimal risk	Reduced public risk. Worker risk somewhat reduced from B.	Lowered risk to public.
Minimal risk	Slight increase in risk to workers and public over Alternative B.	Some reduction in injuries; reduction in fire risk; slight increase in herbacide risk.
Minimal risk	Increased risks over Alternative B.	More injuries. Increased chronic health risks.
Minimal risk	Lower risk than Alt. B; 3 herbicides eliminated.	Reduced risks, especially to public.

applicable land management plans. Overall health risks to workers would be significant for minor injuries. Major injuries should be rare. Chronic health effects may occur from herbicides and smoke. In the "no action" Alternative C, there is a drastic reduction in the use of all methods. Some increases in risk because of noxious weeds or physical hindrances of unwanted vegetation are expected. All human health risks would be markedly reduced.

Alternative D stresses prevention and restricts efforts to control vegetation in areas where adverse effects of the vegetation are fairly certain. All methods other than biological are reduced. Health risks from noxious weeds and unwanted vegetation are not increased. Alternative D results in major reductions in both accidents and potential chronic toxicity.

Alternative E restricts all aerial spraying. All methods except manual and biological are reduced or remain the same. Health risks from noxious weeds and unwanted vegetation are not increased. Under Alternative E, there are likely to be moderate reductions in accidents and disabling injuries. Potential chronic toxicity probably will not change from those under current management Alternative B.

Alternative F restricts the use of prescribed fire methods. The use of fire is reduced considerably, while herbicide use is only slightly increased. Use of manual methods increases slightly, while mechanical methods increase considerably. Biological methods are slightly increased. Health risks from noxious weeds and unwanted vegetation are not increased. There would be a decrease in minor accidents and disabling injuries under this alternative. Some reduction in potential chronic health effects would be expected.

Alternative G calls for increased intensive vegetation management in the National Forests. Herbicide methods primarily will increase, with smaller increases in most other methods. Mechanical methods are moderately decreased. There would be an increase in minor injuries and disabling injuries under this alternative. There would be a moderate increase in potential chronic toxicity.

Preferred Alternative H is an attempt to maximize the effective use of the vegetation management tools while minimizing their human health impacts. Under the preferred alternative, the risk of accidents should remain about the same as under Alternative B, but the risk of herbicide chronic toxicity should be markedly reduced.

Comparing the Public Participation Dimensions of the Alternatives

All eight alternatives emphasize and assure the involvement of interested members of the public in vegetation management decision-making processes, especially in project level planning. Public participation needs will be reviewed during scoping efforts, as an integral part of environmental analysis. Options will be identified for involving potentially interested and affected individuals, organizations, and governments in the analysis process.

NEPA guidelines as implemented in the Council of Environmental Quality Regulations (40 CFR Parts 1500-1508), Forest Service Manual 1950, and Forest Service Handbook 1909.15 will be followed in subsequent environmental analysis.

We will conduct an early and open process for determining the scope of issues, and invite the participation of affected Federal, State and local agencies, Indian tribes, proponents and other interested persons (see 40 CFR 1501.7).

In addition, we will make diligent efforts to involve the public in preparing and implementing their NEPA procedures, provide public notice, hold or sponsor public hearings or public meetings whenever appropriate, solicit appropriate information from the public, explain procedures where interested persons can get information, and make environmental documents available to the public (40 CFR, 1505.6).

Alternative D and H place increased emphasis on the early involvement of members of the public in environmental analysis procedures, and on carrying this participation through to project implementation and monitoring. Under these alternatives, public involvement may occur more frequently and for a longer period of time than for the other alternatives.

In Alternative C, public involvement will occur infrequently, because there is no management of vegetation (unless public health and safety is threatened). If a vegetation management project is proposed, NEPA guidelines as stated above will guide public involvement efforts.

Comparing the Social and Economic Dimensions of the Alternatives

Social Concerns

The human health, public participation, and interagency coordination issues all reflect concerns about attitudes, beliefs, and values, and about our sense of control or self-sufficiency.

As outlined above, the social aspect of the human health question has many perspectives. Alternatives that provide a good response to

legitimate concerns about human health and at the same time have minimal effects on timber production are the ones most readily accepted. Falling in that top group would be Alternatives D, E, and H. Alternatives A, B, F, and G would comprise the next grouping. Alternative C would be the most disruptive.

In terms of public participation, special efforts are made in Alternatives D and H which put them above the rest of the alternatives in terms of emphasizing public involvement. Interagency coordination will vary by alternative with the overall level of activity; otherwise, there will be little difference among the alternatives.

Social and economic effects reflect concerns about the local or regional economy. Those effects are covered in the following section on economic impacts.

Economic Impacts

The analysis summarizes local economic impacts as being those associated with jobs, personal income, and payments to local governments.

No attempt was made to cover other potential effects such as vehicle use fees, vehicle registration fees, income taxes, property taxes, and so on. These potential effects were not quantified because their linkages to vegetation management were convoluted, because they were not expected to vary significantly by alternative, or because they were affected in only a minimal way by vegetation management practices.

Table II-4 shows how the respective alternatives are expected to affect the number of jobs in Oregon and Washington over the coming decade (U.S. Department of Agriculture, Forest Service 1985b, Forest Service Manual, 1972).

These figures include direct, indirect, and induced job effects. They include the logger, the millworker, and the trucker, and also the suppliers who provide them with fuel, machinery, equipment. They also include the effects on other jobs when these people in turn spend a portion of their income in the local economies. (See Appendix B.)

The economic effects are driven primarily by timber harvest levels. Anything done on the Forests that ultimately translates into an effect on timber productivity will result in changes in timber harvest levels. Some of these changes in productivity are very difficult to quantify or even to identify. Others are very straightforward.

Anything a vegetation management alternative does that affects timber productivity affects the allowable sale quantity (ASQ). In this analysis of local economic impacts, the local economies were much more impacted by allowable sale quantity changes than they were by changes in vegetation management practices.

That is why an alternative (such as Alternative D) could call for more labor-intensive vegetation management practices and yet still yield a reduction in the level of jobs. The increased vegetation management work was overshadowed by falldowns in allowable sale quantity.

Vegetation management practices cannot always be substituted directly for each other. Take the case of an alternative in which all tools are available and which treats 100,000 acres annually. A different alternative that forbids the use of fire as a vegetation management tool might end up treating the same number of acres, a greater amount, or a lesser amount.

This is because the substitute tools may require two treatments, compared to only one for fire. Or it may be the case that other measures are prohibitively expensive so that some work is simply not done. In this case, management accepts lower productivity, less output, or a greater risk of loss or damage.

Thus, direct comparisons of alternatives are difficult. It is not simply a matter of switching acres from fire to manual treatments, for instance.

Some people have expressed concern that the economic impacts should be differentiated by treatment: for example, between the kind of local impacts associated with aerial spraying versus manual treatments. Their point is that manual treatments are more likely to employ local residents. However, aliens, migrant workers, and other nonresidents perform a significant amount of work on the Forests. This question is best handled during the NEPA analysis which must be conducted at the project level.

Table II-4

Vegetation Management Jobs – Oregon and Washington

Alternative A	89,600
Alternative B	90,500
Alternative C	72,800
Alternative D	88,700
Alternative E	89,700
Alternative F	87,900
Alternative G	91,100
Alternative H	90,000

Information generated using the IMPLAN local economic impact model. "Jobs" includes permanent and temporary positions, part-time and full-time positions, without discrimination. Figures shown represent average annual conditions over the coming decade and are inclusive of direct, indirect, and induced employment.

Table II-5 shows estimates of job effects by Forest. They do not total to the Regional figures shown in the preceding table (II-4) because the Forest-respective models overlap one another (individual counties are included in more than one Forest model).

This information was generated using the IMPLAN local economic impact model. "Jobs" include permanent and temporary positions, part-time and full-time positions, without discrimination. Figures shown represent average annual conditions over the coming decade, and include direct, indirect, and induced timber-related employment.

Table II-5

Vegetation Management Jobs Associated with Sawtimber Production by Forest

	A	B	C	D	E	F	G	H
Colville	1,546	1,546	1,245	1,480	1,546	1,245	1,546	1,520
Deschutes	1,533	1,572	1,097	1,548	1,572	1,556	1,634	1,564
Fremont	975	1,030	913	975	1,030	1,030	1,084	1,014
Gifford Pinchot	3,876	3,876	3,796	3,876	3,876	3,876	3,876	3,876
Malheur	2,115	2,124	1,691	2,124	2,124	1,907	2,124	2,124
Mt. Baker-Snoqualmie	2,803	2,803	2,539	2,803	2,803	2,622	2,803	2,803
Mt. Hood	3,902	3,902	3,703	3,902	3,902	3,902	3,902	3,902
Ochoco	1,292	1,292	1,281	1,281	1,292	1,292	1,302	1,292
Okanogan	816	816	622	806	816	816	847	816
Olympic	2,544	2,544	2,038	2,517	2,544	2,517	2,572	2,531
Rogue River	1,792	1,832	1,604	1,805	1,805	1,832	1,845	1,818
Siskiyou	2,503	2,520	1,781	2,520	2,520	2,520	2,520	2,520
Siuslaw	4,306	4,396	3,293	4,351	4,396	4,306	4,410	4,381
Umatilla	1,799	1,799	1,075	1,624	1,799	1,355	1,822	1,752
Umpqua	3,521	3,628	1,601	3,553	3,329	3,521	3,702	3,596
Wallowa-Whitman	1,481	1,513	857	1,333	1,513	1,481	1,513	1,460
Wenatchee	1,326	1,379	966	1,358	1,369	1,284	1,390	1,379
Willamette	5,319	5,424	4,880	5,424	5,424	5,424	5,424	5,424
Winema	2,030	2,030	2,030	2,030	2,030	2,030	2,030	2,030

This information was generated using the IMPLAN local economic impact model. "Jobs" include permanent and temporary positions, part-time and full-time positions, without discrimination. Figures shown represent average annual conditions over the coming decade, and include direct, indirect, and induced timber-related employment.

Table II-6 shows how the various alternatives would affect personal income in the states of Oregon and Washington. As in the case of the job information presented above, the great bulk of the effects are caused by anticipated changes in the timber harvest level, and include direct, indirect, and induced personal income effects. Essentially, these personal income figures can be thought of as employee compensation: wages and salaries.

Table II-6

Effects on Personal Income by Vegetation Management Alternative Oregon and Washington

	(In 1987 Dollars)
Alternative A	$2,188,000,000
Alternative B	$2,210,000,000
Alternative C	$1,778,000,000
Alternative D	$2,168,000,000
Alternative E	$2,191,000,000
Alternative F	$2,147,000,000
Alternative G	$2,225,000,000
Alternative H	$2,199,000,000

Information generated using the IMPLAN local economic impact model. Personal income figures include that generated by permanent and temporary positions, part-time and full-time positions. Figures shown represent average annual conditions over the coming decade and include direct, indirect, and induced employment.

Table II-7 shows what would be expected to happen to payments to local governments under the various alternatives. Unlike jobs and personal income information presented above, no payments to local governments result directly from vegetation management practices covered in this EIS.

Table II-7

Vegetation Management Effects on Annual Payments to Local Governments over the Coming Decade
Oregon and Washington

	(In 1987 Dollars)
Alternative A	$206,200,000
Alternative B	$209,200,000
Alternative C	$165,800,000
Alternative D	$206,300,000
Alternative E	$206,800,000
Alternative F	$204,000,000
Alternative G	$210,800,000
Alternative H	$208,200,000

Table II-8 shows how payments to local governments are expected to be affected by the vegetation management alternatives.

Figures shown reflect payments to local governments associated with timber receipts.

Table II-8

Payments to Local Governments by Forest
(In 1987 Million Dollars)

	A	B	C	D	E	F	G	H
Colville	$3.7	$3.7	$3.0	$3.6	$3.7	$3.0	$3.7	$3.7
Deschutes	7.6	7.8	5.4	7.7	7.8	7.7	8.1	7.8
Fremont	7.0	7.4	6.6	7.0	7.4	7.4	7.8	7.3
Gifford Pinchot	17.8	17.8	17.4	17.8	17.8	17.8	17.8	17.8
Malheur	7.1	7.1	5.6	7.1	7.1	6.4	7.1	7.1
Mt. Baker-Snoqualmie	9.2	9.2	8.4	9.2	9.2	8.6	9.2	9.2
Mt. Hood	9.4	9.4	8.9	9.4	9.4	9.4	9.4	9.4
Ochoco	5.9	5.9	5.8	5.8	5.9	5.9	5.9	5.9
Okanogan	1.1	1.1	0.8	1.1	1.1	1.1	1.1	1.1
Olympic	9.2	9.2	7.4	9.1	9.2	9.1	9.3	9.2
Rogue River	9.2	9.4	8.2	9.2	9.2	9.4	9.4	9.3
Siskiyou	14.8	14.9	10.5	14.9	14.9	14.9	14.9	14.9
Siuslaw	18.7	19.1	14.3	18.9	19.1	18.7	19.1	19.0
Umatilla	5.9	5.9	3.5	5.3	5.9	4.4	6.0	5.7
Umpqua	26.0	26.8	11.8	26.2	24.6	26.0	27.3	26.5
Wallowa-Whitman	4.7	4.8	2.7	4.2	4.8	4.7	4.8	4.6
Wenatchee	3.5	3.6	2.5	3.5	3.6	3.4	3.6	3.6
Willamette	32.9	33.6	30.2	33.6	33.6	33.6	33.6	33.6
Winema	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6

Figures shown reflect payments to local governments associated with timber receipts.

As indicated in Chapter IV, the changes seen in the alternatives (except for Alternative C) are well within the usual year-to-year variations in employment, income, and payments seen in the Pacific Northwest. This variations arises in large part from variation in timber harvest levels which are in turn dependent on the level of housing starts and other economic indicators in the national economy.

The community effects of Alternatives A, D, E, F, and H are not positive ones. They are however, on average, significantly less disruptive than the economic fluctuations experienced in the Region's communities over the last ten years, and would be difficult to distinguish from other effects.

Alternative G would contribute to community stability through slightly increased economic activity, but this change is again minor compared to the usual year-to-year changes.

Alternative C would significantly disrupt normal economic activity in the Region, and would have disruptive social effects on some communities.

Comparing the Cost/Benefit Dimensions of the Alternatives

A cost-benefit analysis is relevant to the choices among alternatives of this environmental impact statement, and has been used as an aid in evaluating environmental consequences. To better understand the comparison of the alternatives in the cost/benefit dimension, a short background section introduces the general approach of the economic analysis. More information is presented in Chapter IV and in Appendix B.

Background

The cost-benefit analysis considers all significant dollar-quantified costs and benefits related directly or indirectly to vegetation management practices which are expected to vary by alternative.

Recreation experiences are not expected to vary significantly by alternative; accordingly they have not been dollar-valued in the analysis. The analysis includes all those dollar-quantified costs and benefits (both short-term and long-term) which are expected to be significantly affected by the vegetation management alternatives.

Our approach recognizes costs and benefits as they are expressed in dollar terms in the marketplace. Identified costs and benefits which have not been dollar-quantified are discussed in narrative. Many of the costs and benefits are indirect.

Anything that has been identified as affecting the timber productivity of lands being managed for timber production is reflected in the analysis. This includes delays in achieving reforestation, delays in achieving release, and decreases in yields. All of these are ultimately reflected in the allowable sale quantity (the ASQ, or volume of green sawtimber cut) for the Forests. The analysis does not, however, reflect any kind of falldown from possible losses due to nutrient depletion that might conceivably result from the temporary suppression of competing hardwoods.

If any such significant associations are identified for particular projects, then that association must be identified in the project-level NEPA analysis.

Costs and Benefits

Future costs and benefits are different from those that exist today. We can affect them. Their worth, however, is not the same. Future costs and benefits are converted to today's terms through discounting.

In discounting, a benefit (or cost) occurring today is counted at its full value, while a future benefit (or cost) is discounted using a 4 percent real discount rate. A discounted future value is called a "present value".

A sensitivity test is done to show the decision-maker how the economic efficiency information would be affected by a different real discount rate.

The primary criterion for evaluating economic efficiency is Present Net Value

(PNV) (FSM 1971.2). It is defined as follows.

PVB - PVC = PNV

where,

PVB is the present value of the benefits

PVC is the present value of the costs

PNV is the present net value

The alternative with the greatest economic efficiency is the alternative with the highest PNV.

The economic assumptions and definitions used in this analysis are consistent with those currently in use in this Region for Forest plan-

ning, as it enables tracking results with Forest historical data, management codes, and budgets.

In addition, using a different, credible assumption scenario was not perceived to change the rankings of the alternatives. This is consistent with Forest Service Manual 1970.8-3 (U.S. Department of Agriculture, Forest Service, 1985a) which calls for an analysis that emphasizes significant differences among alternatives rather than emphasizing total measures for each.

The period of the analysis is 100 years, and a 4 percent real discount rate is used (Forest Service Manual 1971.21). Many of the Forests used a 150-year planning horizon to develop their proposed Forest Plans. This enabled them to assure that the timber harvest schedule contained in the document was truly a nondeclining flow schedule.

The 100-year Analysis Period

The 100-year period of analysis is adequate for capturing all significant residual costs and benefits as shown in the following examples (calculated using a 4 percent real discount rate).

Example: A $100 annual payment (over 100 years) has a present value of $2,450. Extending the period to 150 years raises the present value to $2,493, an increase of some 1.8 percent over the 100-year value. Even a 25 percent difference in Present Net Value (PNV) becomes insignificant when applied to a total difference of 1.8 percent. The proportions would remain the same with the use of a different payment value.

No alternative under consideration would have its PNV ranking significantly affected by increasing the period of analysis to 150 years. The changes that do occur in allowable sale quantities after 100 years do not vary significantly by alternative. This is largely because indications are that the Forests will be managed in their aggregate to provide a nondeclining flow of timber. No Forest has proposed a protracted departure from the principle of nondeclining flow.

A 1 percent annual real price increase in stumpage values is assumed to occur over the next fifty years. No real cost changes have been estimated. Stumpage and livestock forage are the benefits tracked in dollar terms.

Dollar-quantified costs are the National Forest costs associated directly or indirectly with vegetation management. Forest Service-tracked permittee costs associated with livestock management and Forest Service-tracked timber harvest costs are also included in the analysis.

Project-level analyses are required to consider the site-specific conditions and to include both short-term and long-term effects.

How the Efficiency Analysis Was Done

The task was to estimate the relative efficiencies of the different vegetation management alternatives, and come up with an understandable bottom line number that reflected how the different themes of the alternatives would affect the National Forests.

The concerns voiced during the public comment period have led to the inclusion of much more information in Appendix B to address such concerns as possible future "tort claims", compensation, nutrient replacement, clean-up costs, underlying assumptions, the timber demand function, and the period of analysis.

The analysis also had to reflect the very real differences that exist among the Region's Forests, and yet be comparable among the Forests.

In order to establish comparability among the Forests, we used their projected fiscal year (FY) 1989 outyear budgets. These budgets shared a common set of definitions, a common reference point in time, and were the most current information available. They were developed with a common understanding that all vegetation management techniques and methods would be available. They also embodied in aggregate the existing proposed Forest Plans, which indicate one possible "likely future" on a Region-wide scale.

In itself that was nothing unusual. The Forests have been projecting outyear budgets based on their proposed Forest Plans for many years. A budget must be based on some anticipated course of action, and a proposed Forest Plan constitutes an acceptable future scenario.

However, the use of a proposed Forest Plan for outyear budgeting or other analytical purposes does not necessarily predispose the decision-maker to select that alternative. Detailed budget analysis may make the Proposed Forest Plan look better or worse in the eyes of the decision-maker.

The fiscal year 1989 outyear budget thus provided the starting point for the analysis. It contained estimated costs for individual budget line items and associated activities and outputs. It became the reference point. It represented a future scenario that would occur if all vegetation management tools and practices were available.

After obtaining this information, it was then necessary to develop estimates of the effects that would occur if vegetation management

practices were to change, in order to show how costs and benefits would be affected. After consulting with Regional Office staff and other resource specialists, it became apparent that there was simply too much diversity in the Region's Forests for the team responsible for the EIS to handle it on their own. The team members responsible for the various facets of the analysis decided in conjunction with management that the best course was to consult with each Forest as to how they would respond (line item by line item) to changes in the ways we manage competing and unwanted vegetation.

That information was then solicited from each Forest for each budget line item. The Forests were free, within the normal constraints of time and personnel, to develop their responses. The amount of effort required on the part of individual Forests varied considerably.

The vegetation management team members then worked with the feedback from each Forest, reviewing the estimates, comparing them with the estimates of other Forests, evaluating them, and consulting with Regional Office staff and others.

From this work, the team developed a synthesis. Sometimes a Forest's input was used as it was provided by the Forest. Other times it was modified based on consultations with the Forest, with the Regional Office, or other experts.

An important part of this process was the development of estimates as to how much the respective Forests' allowable sale quantities would be affected by the alternatives. In fact, this became the biggest part of the efficiency analysis.

Changes in allowable sale quantity caused by changes in vegetation management alternatives had far and away the principal influences on the economic analysis. The Forests and the vegetation management team were aided in this review by the large amount of analysis done at the Forest level in developing the Forest Plans.

FORPLAN estimates of allowable sale quantity effects made during the Forest planning process were particularly helpful. These runs reflect the answers to all manner of "what if" questions including concerns about increasing costs, increasing or decreasing costs and so on. The Forests were encouraged to use this information in developing their estimates of allowable sale quantity effects. The team developing this EIS used the analytical summaries of these analyses as contained in the appendices of the proposed Forest Plan draft environmental impact statements.

The allowable sale quantity effect is so important because it costs a great deal of money to prepare and administer timber sales, and these sales bring in a great deal of money. Small changes in the allowable sale quantity yield are much greater than those associated with changing vegetation management practices.

Comparison of Alternatives

The primary influence in the economic analysis was the costs and benefits associated with the timber resource management program.

Costs and benefits of the range program were also tracked in the economic model, as were other costs associated with vegetation management. Even in aggregate, these other costs were clearly secondary to those associated with the timber program. Only those costs and benefits which were expected to vary significantly by vegetation management alternative were included in the analysis.

Discussion with Region and Forest-level personnel disclosed no real concern that any of the alternatives would significantly affect other dollar-quantifiable outputs such as recreation visits, mineral outputs, water quality, or water quantity. Therefore these were not tracked in the analysis.

Some people do feel that their recreational experience, for instance, would be affected (either quantitatively or qualitatively) by the character of the alternative finally selected. In such cases, some individuals might have to use a different site, reschedule their recreation experience, or participate in a different type of recreation altogether. Generally, however, the periods of the treatments are short, and, scheduled in such a way as to minimize conflicts with recreational users. We have predicted no changes in recreational use (either on or off the National Forests) as a result of implementing any of the vegetation management alternatives.

The salient characteristic of the analysis is that changes in vegetation management are expected to result in changes in the Region's overall level of timber offerings from what would otherwise be possible in any alternative. To some extent this conclusion is speculative, as volume lost on one Forest may be made up by increasing the volume harvested on another. Allowable sale quantity, based on assessment of draft Forest Plans and other analysis, would be expected to be about 3.8 to 4.3 billion board feet per year, under Alternative B, which is used as a reference in this document.

Based on the characteristics of the timber inventory of each National Forest, the change in timber sale offerings may be immediate or may only come about in the distant future. The question is complicated by the fact that Forests in the Region are considering a wide range of timber harvest levels as well as alternative harvest schedules. For the sake of simplicity, we used Forest-respective estimates of effects on the allowable sale quantity of each Forest.

During the construction of the alternatives, every attempt was made to make the alternatives as realistic as possible. For instance, forcing 100 percent achievement of a timber goal would have made some alternatives tremendously costly. The more realistic approach was to strive to meet the target with some increase in unit and total costs.

Thus, there was no assumption that budgets were unlimited. Further information on the development of costs is contained in Appendix B. It also contains details of the process for determining costs. Alternatives Considered but Eliminated from Further Study in this chapter and Appendix B both provide more details on how the budget and output emphases were handled.

Viewed from a total budget perspective, costs associated with vegetation management are quite small. Substantial changes could occur in the vegetation management component of some individual budget line items that would go almost without notice at the level of the overall budget.

The impacts of such changes are felt when they result in changes in the timber program. A shift in the allowable sale quantity for a Forest affects its entire budget because the timber program funds much of the engineering, fire protection, and other program activity at the Forest level. Thus small changes in vegetation management practices can translate into much larger cost and benefit changes.

The great bulk of the cost information contained in Table II-9 below is not associated directly with vegetation management. None of the benefit information is directly related to vegetation management since the benefits of vegetation management are tracked in other Forest outputs such as timber offerings. Vegetation management is an activity rather than an ouput.

Table II-9

Economic Efficiency Criteria
(4 Percent Discount Rate, in 1987 Dollars)

	Present Value of the Benefits Alternatives (PVB)	Present Value of the Costs (PVC)	Present Net Value (PNV)
A	$25,354,000,000	$14,372,000,000	$10,982,000,000
B	26,061,000,000	14,482,000,000	11,59,000,000
C	19,837,000,000	11,041,000,000	8,796,000,000
D	25,663,000,000	13,942,000,000	11,720,000,000
E	25,779,000,000	14,239,000,000	11,540,000,000
F	25,362,000,000	14,238,000,000	11,124,000,000
G	26,375,000,000	14,574,000,000	11,801,000,000
H	25,909,000,000	14,334,000,000	11,575,000,000

See Appendix B for additional information about the analysis leading to this table.

Allowable sale quantities specific to each National Forest are presented elsewhere in this chapter, as is other Forest-specific information.

As shown in Table II-9, Alternative G has the highest present net value (PNV) of any alternative considered. Alternative G allows the greatest level of flexibility in managing competing vegetation. Alternative D was a close second. Basically this means that the Forest Service could move from Alternative B (the "pre-injunction" constraint set) to either Alternative G or Alternative B and come out better in terms of net dollar-quantified benefits.

A decision to select an alternative with a lower PNV means the decision-maker has decided that the net benefits not counted in dollar terms more than make up the loss in net benefits which are expressed in dollars.

Alternatives H and E also score high in economic efficiency. The net economic effects of the additional restrictions they impose (relative to Alternative B) are quite small -less than 1/2 of 1 percent. Much of the decrease shown in the present value of the costs (PVC) comes

about as a result of an anticipated decline in Forest timber offerings. A relatively small part is savings from decreased treatments. Other treatment costs actually increase because of the additional constraints on tools and operating procedures.

Alternatives A and F have PNV's which are quite close to one another. Their costs fall, relative to Alternative B, but their benefits fall even more. The reduction in costs is largely that associated with decreased timber production, though some vegetation management work is foregone because substitute vegetation management treatments are inappropriate.

Alternative F sharply restricts the use of fire as a tool for managing competing and otherwise unwanted vegetation. Fire is commonly used in support of many Forest programs. In some instances, there is no other cost-effective substitute presently known. If the tool is not available, the work simply will not be done. Many acres of wildlife habitat improvement work which rely on the use of fire would not be done. This could lead to a decrease in the amount of quality habitat for some species from using fire.

Alternative A has the next-to-lowest present net value. The exclusion of herbicides and the substitution of more costly measures causes a significant decrease in present net value. Use of more costly measures prevents a greater loss in the timber program than would otherwise have been the case, but their use is not sufficient to prevent a significant reduction in timber sale offerings.

Because vegetation management is so severely restricted in Alternative C, sawtimber production would be greatly reduced. Thus, Alternative C has the lowest present net value. The restrictions in this alternative are so severe that massive reductions in Regional timber sale offerings would be needed. That generates sharp decreases in benefits, which outstrip reductions in costs.

Table II-10 used the same input data as was used for Table II-9; however the output was calculated at a 7-1/8 percent discount rate. This is the discount rate used in the most recent Resources Program and Assessment (Forest Service Manual 1971.21see US Department of Agriculture, Forest Service, 1985a). This enables the decision-maker to see the effects of such a change. The analysis process was not driven by the discount rate. The selection of activities and outputs would be the same even were a different discount rate to have been selected. The model we used was not an "optimizing" model such as FORPLAN. Rather, the alternatives were constructed to respond in

different ways to the issues, concerns, and opportunities which surfaced during the scoping process.

Each alternative had its own unique blend of emphases which were not triggered by the selection of a discount rate. The mix would have been the same even had the discount varied up or down by five points. Changes greater than that would likely indicate a profound shift in the nation's political economy which would in turn shift the identification of issues, concerns, and opportunities.

Table II-10

Economic Efficiency Criteria Sensitivity to Discount Rate
(7-1/8 Percent Discount Rate, in Millions of 1987 Dollars)

Alternatives	Present Value of the Benefits (PVB)	Present Value of the Costs (PVC)	Present Net Value (PNV)
A	$14,619	$8,279	$6,340
B	14,948	8,315	6,633
C	11,680	6,407	5,273
D	14,732	7,983	6,748
E	14,801	8,156	6,645
F	14,559	8,155	6,404
G	15,099	8,353	6,746
H	14,871	8,233	6,638

See Appendix B for additional information about the analysis leading to this table.

Forest Service Budgets

The alternatives require different levels of funding for the Forest Service to implement the alternatives. These levels appear in Table II-11. As shown there, only Alternative A has the vegetation management budget effects greater than allowable sale quantity budget effects.

The budget figures show the combined effects resulting from changes in timber harvest levels, changes in the level of permitted livestock grazing, and the changes in vegetation management practices. The rankings by budget are very similar to the expected harvest level rankings. Some small shifts in expenditures do occur due to the mix of vegetation management practices in each alternative.

In some instances the relationships among alternatives (in terms of acres treated or dollars expended for treatment) seem obtuse. An alternative may, for instance, preclude the use of a particular tool which has no ready substitute. In such cases, management may elect to do no work at all. This happened on some Forests on the Eastside of the Region when the use of fire to improve wildlife habitat was prescribed. Some managers could identify no cost-effective tool that could replace fire, and decided to allocate those dollar resources to improve wildlife habitat in different ways.

It is also true that many treatment practices or methods are not directly substitutable. For instance, an acre of treatment once a year by one method may be replaced by twice-annual treatments by another method.

Budget effects which result from changing the allowable sale quantity interact with budget changes resulting from changes in vegetation management practices. An alternative may have increased vegetation management practices and a falldown in allowable sale quantity. In such a case, it is quite possible that the reductions in budget costs associated with a lowered allowable sale quantity may overshadow the increased costs of vegetation management. These kinds of relationships are presented in more detail in Appendix B.

Table II-11

Annual Forest Service Budgets over the Coming Ten Years
(In 1987 Million Dollars)

	A	B	C	D	E	F	G	H
Budget Change Resulting from ASQ Effects [1]	-$4	-0-	-$173	-$22	-$9	-$19	+$1	-$4
Budget Change Resulting from Vegetation Management Practices [2]	+$5	-0-	+$64	+$5	+$2	+$11	-0-	+1
Total Change in Budget	+$1	-0-	-$109	-$17	-$7	-$8	+$1	-$3

[1] These are changes in the budget which result from changes in the allowable sale quantity (ASQ). That is, the theme of the alternative causes changes in the allowable sale quantity which causes these budget impacts. An alternative that restricts timber management would be expected to show a lower allowable sale quantity and lower levels of expenditures associated with the allowable sale quantity.

[2] These are changes resulting from shifts in vegetation management practices.

Comparing the Environmental Effects Dimension of the Alternatives

Environmental Effects

Each of the alternatives has the potential to affect physical and biological components of the environment, such as air quality, water quality and quantity, soil, vegetation species and diversity, and fish and wildlife. All of these environmental components are interrelated, so that changes in one component may cause changes in others. See Chapter IV, Environmental Consequences, for a complete discussion of possible direct and indirect effects of vegetation management activities on these components of the environment.

All alternatives would employ the same mitigation measures governing implementation of a particular method or technique for management of competing or unwanted vegetation. The mitigation measures are listed in Chapter II following a description of each of the methods. For example, on a given site where mechanical methods are employed, all of the alternatives would limit tractors to slopes of less than 35 percent, and limit these operations to conditions that minimize the potential for compaction.

The alternatives do vary in the extent of treatment and methods available. Therefore, for alternatives that allow more acres to be treated with methods having a potential for adverse impacts (on any given resource), there is a higher risk of adverse impacts occurring. For example, alternatives involving extensive use of prescribed burning would have a higher risk of impacting air quality than those that minimize the number of acres burned.

Effects on Soil, Water, Long-term Productivity, and Air

The potential for effects on soil, water, long-term productivity and air quality varies between alternatives. Mechanical and biological methods of vegetation management, as well as use of herbicides and prescribed burning, may affect these resources.

For manual methods, there is a lower potential for impacts—and less variation (between alternatives) in acres treated than for any other method available. Table II–12 displays the acres likely to be treated each year under each of the alternatives.

Effects on air quality are related to the amount of prescribed burning that would occur under each alternative. These effects can be estimated using the the total suspended particulates produced by the use of prescribed fire under each of the alternatives (Table II-13). All of the alternatives meet the objectives of the State Implementation Plans and the State Smoke Management Plans of Washington and Oregon.

Table II-12

Acres Treated Using Methods Having Potential Impacts on Physical and Biological Resources
(in thousands)

Alternative	A	B	C	D	E	F	G	H
Method								
Herbicides	0	60	0	27	48	64	77	51
Mechanical[1]	168	161	36	104	158	193	147	162
Biological	15	4	4	19	6	8	7	7
Burning	202	210	0	126	194	176	215	202
Total	385	435	40	276	406	441	446	422

[1] Does not include roadside and mechanical brushing for rights-of-way.

Table II-13

Average Annual Production of Suspended Particulates Less than 2.5 Microns in Diameter Produced by Prescribed Fire
(in tons per year)

Alternative	A	B	C	D	E	F	G	H
Tons of suspended particulates less than 2.5 microns in diameter per year	37	37	0	22	33	24	38	37

The following discussion compares the alternatives in increasing order of potential effects on soil, water, and air resources, and long-term productivity.

Alternative C, the "no action" option, would manage the fewest acres of competing and unwanted vegetation. There would be no risk of contamination of soil or water resources from herbicides. There would also be no risk of adverse effects on air quality or long-term productivity from use of fire as a management tool. Adverse effects on soil and water from mechanical methods of vegetation management would be minimized.

Alternative D would result in the fewest acres treated of any of the action alternatives, due to the prevention philosophy of this alternative. There would be some risk of contamination of soil and water resources by herbicides, but it is low compared to other alternatives which include use of herbicides. There would also be a low potential for adverse impacts on air, soil, and water resources from prescribed burning. This alternative also involves the fewest acres mechanically treated, with low risk of impacts on the soil and long-term productivity. Alternative D would involve the most acres treated with biological methods of vegetation management. This could result in positive or adverse impacts on a site, depending on site conditions and the technique employed.

Alternative A prohibits the use of herbicides, with a resulting increase in use of mechanical, biological, and prescribed fire methods. While total acres treated is 1.5 times greater than Alternative D, it is less than the other action alternatives. Alternative A involves a moderately high acreage treated using mechanical methods and prescribed burning, and a significantly higher risk of adverse impacts on air, soil, and water resources as compared to Alternative D. Therefore, the potential for an adverse impact on long-term productivity is also higher.

Alternative E would not involve aerial spraying of herbicides and would prohibit use of certain herbicides. While nearly twice as many acres would be treated with herbicides as Alternative D, the closer control obtained by backpack and truck-mounted sprayers would reduce the risk of water contamination. However, the potential for adverse impacts on soils and long-term productivity would be higher than Alternative D due to the increased acreage treated using mechanical methods and prescribed burning. Compared to the other action alternatives, Alternative E has a medium risk of potential impacts on air, soil, and water resources.

Alternative F would result in a reduction of acres treated by prescribed burning for reduction of activity fuels (logging slash), but would still result in a higher use of burning than Alternative D. Alternative F also involves an extensive use of mechanical methods, and overall a high total number of acres treated. This would lead to a higher risk of adverse impacts on soil, water quality, and long-term productivity than most of the other alternatives. Risk of soil and water contamination from herbicides is greater under this alternative, compared to the other alternatives.

Alternative B is similar to Alternative F in overall acres treated and use of herbicides. Fewer acres would be treated using mechanical methods, but more acres would be treated by prescribed burning than Alternative F. This would result in a higher potential for immediate impacts on air quality. The potential for impacts on soil, water, and long-term productivity is similar to that under Alternative F.

Alternatives G involves extensive use of prescribed burning and herbicides, and slightly lower use of mechanical and biological methods than the other action alternatives. This alternative poses the highest risk of soil and water contamination from herbicides. Alternative G would result in the highest emission of total suspended particulates each year. Risk of adverse impacts to soil, water and long-term productivity is relatively high from extensive use of fire as a management tool. However, the relatively low number of acres of mechanical treatment would reduce the risk of adverse impacts on soil and water from the use of this method as compared to the other alternatives.

Alternative H : All methods are available under this alternative, although three herbicides (amitrole, fosamine, and diuron) are not available, and prescribed burning for slash reduction will be restricted. Herbicide-treated vegetation will not be burned for a year following treatment.

The reduction in slash burning means that the reduction in emissions will be about equal to that projected for Alternative D (63 percent lower west of the Cascades, and 60 percent lower on the east). Emissions reductions will be about twice that projected for Alternative B (33 and 35 percent, west and east, respectively).

No reduction in long-term sustained yield capability is projected for Alternative H, compared to Alternative B. Long-term sustained yield capability for H is approximately 17 million board feet higher than for Alternative D. Due to the reduction in slash burning in Alternative H, a slight increase in nutrient availability and long term productivity (similar to that for Alternative D, and slightly greater than that for Alternative B) will occur.

The emphasis on preventive measures should improve the effectivenss of treatments over time, as the need for subsequent corrective action is reduced. Management emphasis under this alternative also tends to encourage more creativity in dealing with site-specific problems.

Effects on Riparian Areas, Fish, and Threatened and Endangered Species

Each of the Forests in the Region has developed management guidelines for riparian areas based on local conditions. Although vegetation management activities may affect riparian vegetation, there will not be a significant variation among alternatives in effects on riparian vegetation. Since fish habitat largely depends on the condition of the adjacent riparian area, there will not be a significant variation in effects on the fisheries resource between the alternatives.

All alternatives involving the use of herbicides require a 50- to 200-foot minimum unsprayed buffer for streams and surface waters to minimize the effects of herbicides on riparian vegetation. An unburned vegetative buffer strip is also required for prescribed burning.

Since fish habitat largely depends on the condition of the adjacent riparian area, there will not be a significant variation in effects on the fisheries resource between the alternatives. The potential effects on fisheries include increased risk of sediment (primarily from mechanical methods and burning), and toxicity due to herbicide spills or drift. See Chapter IV for a complete discussion. All of the alternatives will protect threatened and endangered species in accordance with the endangered species act and with direction found in Forest Service Manual 2670.

Effects on Diversity

All alternatives will have similar impacts on vegetation diversity within the Region. Existing laws as well as the mitigation measures governing implementation of each method will determine the impact of management of competing and unwanted vegetation on diversity. However, Alternative C, with the higher hazard of extensive, intense wildfire, has the greatest potential for affecting vegetation diversity.

Effects on Wildlife

There is a low probability that any of the alternatives considered will result in a significant adverse impact to the viability of any wildlife population in the Pacific Northwest Region.

Alternative C creates the highest long-term risk because it limits vegetation management opportunities for improving or maintaining habitat suitability.

Alternatives B, F, G, and H have the highest potential for impact on wildlife populations at the project level, because, under all four, a

higher number of acres are managed intensively, using all available methods in "preventive" and "corrective" strategies.

Comparing the Effectiveness of Techniques Dimensions of the Alternatives

These two strategies are also used in Alternative A, which has a program similar in size to Alternatives B, F, G, and H. However, the restriction on use of herbicides in Alternative A reduces the risks to wildlife populations.

Alternative D proposes a significantly smaller program and emphasizes a preventive rather than corrective strategy. Alternative H will emphasize a long-term reduction in the reliance of chemical herbicides for vegetation management. This will reduce risks to wildlife populations. Preventive strategies are usually implemented early and provide many opportunities to mitigate potential adverse consequences. Corrective measures tend to be more disruptive to wildlife habitat.

The issue area looks at the ability of forest managers to fit vegetation management tools to the appropriate site conditions, given the constraints of each alternative.

The success of any treatment is measured by how well the prescription or management objectives are met. For example, a silvicultural treatment is often evaluated against standards for seedling survival and vigor following the reduction of competing vegetation. The anticipated conifer growth response can be measured against predetermined standards for plantation development. A common objective in roadside maintenance may be an improved line-of-sight for motorists. Management goals are defined prior to treatment in order to establish measurable standards for the monitoring of results.

Any treatment method will be successful when applied in the proper set of site-specific circumstances and performance levels.

In Table II–14, the relative effectiveness of vegetation management under each alternative is displayed, using a scale of 1 (ineffective) to 10 (highly effective).

Table II-14

Relative Effectiveness of Vegetation Management

Alternative	A	B	C	D	E	F	G	H
Relative Effectiveness	8	10	1	9	8	8	10	9

key: 1 = ineffective
10 = highly effective

Much of the background for this section is found in the appendices. Appendix E (Silviculture Program Effects for Site Preparation and Release) includes examples of the successful use of methods within some specific operational and biological limitations. Appendix C (Herbicide Use and Efficacy) describes the relative effectiveness of chemicals and some typical target vegetation. Appendix A (Timber Growth and Yield) evaluates some specific situations in which treatment effectiveness is reduced due to operational or environmental factors.

Alternative A

The suspension of the use of herbicides will result in reduced treatment effectiveness in silvicultural situations. This is primarily due to reduced duration of vegetation control when target vegetation has the potential for aggressive site reoccupancy. For example, on the average (Region-wide), it has taken an estimated 1.8 manual cuttings—compared to 1.1 herbicide treatments—to adequately meet prescription release objectives.

Reduced treatment effectiveness will be most apparent when dealing with sclerophyllous species, such as with stands containing a well established tanoak or madrone component. Certain other woody shrubs and herbaceous species will also present some difficult problems in the absence of the use of herbicides (see Appendix A).

A reduction in treatment effectiveness in these vegetative conditions will translate into tree mortality and growth loss in managed young timber stands. The estimated reductions in long-term sustained yields shown in Appendix A are:

Vegetation Complex	Yield Reduction
Ponderosa pine/shrub/herbaceous	4%
Conifer/Ceanothus spp./herbaceous	5%
Douglas-fir/tanoak-madrone	19%
True fir-hemlock/shrub/herbaceous	7%
Balance of suitable lands	5%

Region-wide, this growth effect could eventually result in a modest reduction in harvest levels of approximately 5 percent, or 190 to 215 million board feet annually. While these potential harvest level effects are relatively small, the impact will tend to be concentrated on National Forests in the southern Cascades and subregions.

Likewise, there will be reduced effectiveness of treatment in certain roadside maintenance and noxious weed control situations. Region-wide, this effect will be relatively minor, but it may be significant in specific National Forests.

Alternative B

This alternative is used as a reference for the evaluation of other alternatives. All tools and techniques are available for use in the appropriate environmental setting. This is expected to translate into optimum effectiveness for operational vegetation management programs.

Timber harvest levels (allowable sale quantity) are anticipated to be approximately 3.8 to 4.3 billion board feet annually, following implementation of Forest land management plans. This alternative also allows the management flexibility to assure treatment effectiveness in programs such as right-of-way maintenance, range improvements, and noxious weed control.

Alternative C

Only that vegetation management necessary to meet legal obligations in the area of human health and safety will occur under this alternative. On most Forests, this would involve a limited amount of roadside vegetation control. Timber yields would be reduced by an estimated 25 to 50 percent (see Appendix A), as severe stocking losses and early growth effects occur.

The following eventual decrease in timber yield is anticipated:

Vegetation Complex	Yield Reduction
Douglas-fir/alder	25%
Douglas-fir-hemlock/salmonberry	21%
Ponderosa pine/shrub/herbaceous	52%
Conifer/Ceanothus spp./herbaceous	39%
Douglas-fir/tanoak-madrone	65%
True fir-hemlock/shrub/herbaceous	46%

The greatly reduced success of the reforestation program would trigger major changes in the timberlands "suitability" classifications made in the Forest Land Management planning process.

Alternative D

All methods are available under this alternative, although added caution and reduced tolerance for data gaps and uncertainty will translate into reduced program accomplishment in the short-term.

For example, estimates from the 19 Forests indicate that 12 percent of the silvicultural diagnoses would result in a no-treatment or deferred action decision under Alternative B. Under Alternative D, however, an estimated 26 percent of these prescriptions would be a deferred or "no action" decision (see Appendix E). This means that roughly an additional 15,000 acres per year will be left untreated.

As knowledge is gained through the increased emphasis on research and monitoring, the vegetation management programs will tend to become more effective and efficient.

In the short-term, however, the Forests anticipate a modest reduction in timber yields as a result of the deferred action under this scheme of management. This potential yield reduction is estimated to be 1-1/2 to 2 percent per year (approximately 55 to 85 million board feet).

An emphasis on preventive measures should improve the effectiveness of treatments over time as the need for subsequent corrective action is reduced. Management emphasis under this alternative also tends to encourage more creativity in dealing with site-specific problems.

Alternative E

Aerial herbicide application is discontinued, and manual cutting will become more restricted under this alternative. Four herbicides—2,4–D, amitrole, diuron, and fosamine—will not be used. The use of bromacil, 2,4-DP, and simazine will also be limited under this alternative.

Effectiveness of vegetation control will be reduced on steep terrain, and on sites occupied by tall or dense competing vegetation. The Forests also indicate that a slight increase in deferred action and no-treatment decisions will occur in comparison with Alternative B (approximately 1,000 additional acres per year).

In general, however, the substitution of methods under this management scheme will maintain a generally high level of program effectiveness. The estimated potential decrease in timber yields is 1 to 1-1/2 percent (approximately 35 to 65 million board feet).

Some reduced treatment effectiveness will be seen in the roadside maintenance program because the herbicides amitrole, 2,4-D, diuron, and fosamine are no longer available for application. Regionwide, the effect will be relatively minor, although the cost of doing business will increase.

Alternative F

The elimination of prescribed fire as a site preparation tool is the principal program effect under this alternative. The limitation on broadcast burning will also restrict some rangeland rehabilitation efforts in the East-side subregion.

In certain situations, the suspension of controlled burning will have a negative effect on reforestation success. This will occur primarily where concentrations of brush or logging residues create physical obstructions to reforestation. The result in these cases will be more non-stocked and understocked inclusions within managed stands. In extreme situations, adjustments in the "suitable timberlands" classification may result. The Forests have estimated that 2-1/2 to 3 percent of the suitable landbase will be affected. This represents approximately 95 to 125 million board feet annually in reduced timber yields.

Substitution of other methods for fire use, and more aggressive yarding of non-merchantable material during logging, will maintain treatment effectiveness at satisfactory levels in the great majority of situations. Appendix E contains an assessment of reforestation success in the absence of prescribed fire. Forests in the Coastal and southern Cascades subregions will tend to be most affected by this alternative.

Alternative G

The enlarged program of work is the principal factor related to treatment effectiveness under this alternative.

As in Alternative B, all techniques are freely available. For example, there is a 12 percent increase in cultural treatments in comparison with other alternatives. The Forests have estimated that this intensified management will eventually translate into a 2-1/2 to 3 percent increase in timber yields (approximately 95 to 125 million board feet per year).

An improved tree per acre stocking level in some difficult reforestation conditions is the primary beneficial effect seen under this alternative. The more aggressive management scheme will also present opportunities to enhance the effectiveness of certain right-of-way, rangeland improvement, and noxious weed control efforts.

Most of the intensified management effort, however, will occur on lands that are considered only marginally suitable for regulated timber harvest. This will often mean that some cost efficiency is sacrificed, and the risk of adverse effects related to site productivity increases. A typical example may the conversion of some non-commercial hardwood stands growing on sites with skeletal of poorly developed soil profiles in the southern Cascades.

Alternative H

Restraints on the use of herbicides and a moderate increase in no-action or deferred treatment decisions (compared to Alternative B) are factors which may relate to treatment effectiveness under this alternative.

Under H, use of three herbicides (amitrole, diuron, and fosamine) is suspended. Other herbicides (reviewed in this document), will be used only when needed to meet management objectives. The anticipated herbicide program is 75 percent of that which would have occurred under Altenative B. Emphasis on the development of preventive strategies and improved treatment monitoring schemes will result in roughly 7,000 acres of additional no treatment or deferred action decisions compared to Alternative B.

All techniques are available to meet prescription objectives. Managers will have the latitude to use herbicides or fire when a need truly arises. This flexibility in the use of management tools leads to a conclusion that no short-term or long-term timber yield effects will be seen under this alternative. Likewise, the overall effectiveness of roadside treatments, range rehabilitation, noxious weed control, and other vegetation management efforts can be maintained under this alternative.

On balance, no measurable change in treatment effectiveness is anticipated under Alternative H.

Comparison of the Interagency Coordination Dimensions of the Alternatives

In all alternatives, coordination with federal, state and local agencies is emphasized and assured. National Environmental Policy Act (NEPA) guidelines as implemented in the Council of Environmental Quality Regulations (40 CFR, Parts 1500-1508), Forest Service Manual 1950, and Forest Service Handbook 1909.15 will be followed.

This includes establishing cooperating agencies where appropriate in the analysis process, and including affected agencies in all public participation efforts. For vegetation management projects, key agencies include state and federal natural resource agencies, state depart-

ments of transportation and agriculture, and appropriate health agencies. Contacts with local offices of these agencies and other independent local agencies is especially important in project-level planning.

Under Alternatives A and C (which prohibit use of chemical herbicides), there may be a need for increased coordination between the Forest Service, state departments of agriculture, and county weed boards in managing noxious weed populations.

Chapter 2
The Alternatives

Alternatives Elminated from Detailed Study

Alternatives Considered But Eliminated from Detailed Study

This section describes alternatives that were suggested and considered during the draft phase of the EIS, but not studied by the interdisciplinary team as fully as the final seven alternatives. There is also an explanation as to what was learned from studying these other alternatives before eliminating them. During the final phase of the EIS, an eighth alternative was fully developed.

During the writing of this EIS, the Oregon Legislature was considering legislation to aid in the abatement of air pollution caused by open burning (including the burning of logging slash). Consideration was given to building and analyzing alternatives which would specifically examine how the Forest Service would conduct its programs in light of that potential legislation. However, the specific provisions of the law are not yet apparent, and such an alternative concerning it would be highly speculative.

The seven alternatives considered in detail during the draft EIS do address the effects of various levels of prescribed burning on air quality. All alternatives have levels of prescribed burning that will meet the State Implementation Plan goals for total suspended particulates (TSP) by the year 2000. New Alternative H will also meet those goals.

Alternative Responding to Oregon Air Quality Legislation

Three of the original seven alternatives reduced the use of prescribed burning. Alternative C prohibits all use of prescribed fire for vegetation management; Alternative F explicitly forbids the use of fire for site preparation work; Alternative D uses less fire because its preventive techniques are expected to reduce vegetation management problems. New Alternative H calls for a reduction in the use of prescribed fire for treating slash.

The data base and the model used in analyzing fire and air pollution effects of the alternatives will continue to be available for analyzing the effects of any new programs, legislative or otherwise.

Maximize Employment

This alternative would have stressed the use of labor-intensive practices in managing vegetation. The alternative was not developed because initial analysis showed that it would require larger budgets than could be reasonably expected.

The alternatives do cover a substantial range of job levels. Alternative G does explore enhanced employment through increased commodity production. Alternatives which prohibit herbicides (A and C) both would result in a net decrease in employment.

A vegetation management alternative designed specifically to address the needs of the unemployed is considerably outside the scope of this EIS. As a "jobs program", it would be more normally developed in legislative programs.

Employment generated by vegetation management activities is quite small relative to the overall level of employment generated in the Pacific Northwest from Forest Service programs and activities.

Initial analysis showed a high-production, labor-intensive alternative would require a very high level of additional funding. Given the concerns that the alternatives needed to be as economically efficient as possible, and within probable budgets, the interdisciplinary team eliminated this alternative from detailed study.

Budget and Output Emphasis Alternatives

During the formulation of alternatives, concern arose that the descriptions of Alternatives A, D, E, and F were not sufficient for an adequate understanding of their management implications and environmental consequences.

The specific question was whether commodity outputs or operating budgets would have precedence when estimating what the vegetation management program would be like. (Forests operate within a budget, and have expected levels of work activities to perform. These result in expected levels of commodity production, also called "outputs".)

Vegetation management methods vary in their economic efficiencyv: some cost more for the same result. Specialists on the National Forests could estimate the management implications of the alternatives in two ways. They could assume that extra budget funds would be available in order to produce the expected outputs; or they could reduce expected level of outputs when less efficient methods of vegetation management absorbed all the budget funds for it.

Some increase in budgets could reasonably be expected if they

were needed to further management objectives. By the same token, the budget could not be viewed as totally flexible in responding to Forest targets: the Forests could not expect a blank check.

Rather than making a decision at the Regional level as to whether budget or outputs would take precedence, input on the question was requested from the Region's National Forests. Each Forest was asked to indicate how they would respond to Alternatives A, D, E, and F, both with a budget-constraint emphasis and with an output-constraint emphasis. For example, each Forest constructed two separate estimates of costs for Alternative A:

one for attempting to meet the output levels specified in Alternative B, even in the face of substantial increases in costs; and

one for attempting to meet the output levels specified in Alternative B only insofar as would be possible with relatively minor increases in costs.

After reviewing the information from the Forests for these paired alternatives, it became clear that the overall purpose and theme of the original alternatives had more influence than either the budget or output emphases.

In general, cost differences between the paired alternatives were quite small. In the A and the D pairings, 82 percent of the budget line items differed by less than 10 percent. Moreover, in A's pairings, more than half the Forests showed no difference between the paired alternatives at all. Those Forests literally saw no difference between an Alternative A with an output emphasis and an Alternative A with a budget emphasis.

Alternative E showed even less of a difference between its two members, with 88 percent of the budget line items differing by less than 10 percent. In the case of the Alternative F pairings, budget line items differing by less than 10 percent amounted to 94 percent of the total.

In some instances the Forests were able to use substitute methods which closely approximated the cost and the efficacy of the excluded methods. In other instances, the substitute measures were prohibitively expensive. In those cases, the work was not done, and the effect was noted as a reduced output level. Each alternative had a unique

mixture of vegetation management practices.

In the draft EIS, the vegetation management team was faced with the prospect of analyzing two very similar alternatives for the themes present in each of the Alternatives A, D, E, and F. That duplication would have meant a lot of extra work with very little gain in knowledge.

Accordingly, the interdisciplinary team agreed that team members responsible for compiling specific Forest information would review and validate their data. They were then to determine which data from the pairings best represented the levels of activities and costs that best fit the theme of the alternative.

Thus, in their present form, Alternatives A, D, E, and F represent the most reasonable and likely balance of costs and work (outputs) that would be expected, given their respective themes.

Duplicate the Pre-Injunction Program

Initial alternatives included both the present (1986, with herbicides prohibited) and the pre-injunction (before 1984, with herbicides allowed) vegetation management programs. They were eliminated from detailed consideration.

These conditions are approximated in Alternatives A and B, respectively, although in their final form Alternatives A and B both look forward toward future implementation, rather than trying to duplicate an earlier scenario. There was little point in developing alternatives that do not take into consideration the knowledge gained in recent years in vegetation management and which would not be responsive to the issues identified in our scoping process.

Chapter 2
The Alternatives

Implementing the Alternatives

Implementing the Alternatives

Environmental Analysis

As noted at the end of Chapter I, Forest Service actions that affect the physical and biological environment are first examined in an "environmental analysis". Environmental analysis (sometimes called "the NEPA process") requires a thoughtful examination of the action, alternative ways of doing (or not doing) it, and their consequences.

Vegetation management actions affect the physical and biological environment. Therefore, they all require an environmental analysis. As explained in Chapter I, this environmental analysis may be written up in an "environmental assessment" (EA), as an "environmental impact statement" (EIS), or not written up at all (if it is "categorically excluded").

In this EIS, when an environmental analysis is conducted for an action or project to manage competing and unwanted vegetation, additional emphasis will be given to five aspects of the established analysis and decision-making process. (See Figure II-4.)

Figure II-4

"Five Steps" in Managing Competing and Unwanted Vegetation

Site Analysis
: What's there? What's likely to happen? What are Forest Plan goals?

Select Strategy
: When to act? What strategy to use?

Design Project
: Incorporate specific requirements, mitigation measures, risk management plans, and reporting and training requirements. Use only permitted tools. Include Forest Plan standards and idelines.

Action
: Do the work.

Monitor
: Successful project? What was learned? More work needed?

These five aspects of the NEPA process–the "five steps" discussed here–focus attention on the site-specific ecological context of the competing or unwanted vegetation; carefully examine when action is needed; design and conduct the project carefully; and provide for follow-up on (and learning from) the project.

Figure II-5

How the Five Step Vegetation Management Process Fits within Environmental Analysis

Environmental Analysis ("The NEPA Process")*	Vegetation Management Process
Scoping	
- identify the action	Site Analysis
- identify agencies and responsible official	
- look for issues	
- explore possible effects and existing direction	Site Analysis, Select Strategy
- assess public participation needs and make contacts	Design Project
- identify skills needed	Design Project
- convene interdisciplinary team, identify cooperators, assign tasks	Design Project
- expand public involvement as appropriate	Design Project
- plan for an orderly analysis (analysis criteria, issues, alternatives, other analysis, public involvement)	Site Analysis, Design Project
Collect Data	Site Analysis
Interpret Data	Select Strategy
Develop Alternatives	Design Project, Site Analysis
Estimate Effects	Site Analysis, Select Strategy
Evaluate Alternatives	Select Strategy
Identify Preferred Alternative(s)	Select Strategy
Documentation (if appropriate)	
Decision	Select Strategy
Implementation	Action
Monitoring	Monitor

* Adapted from Exhibit 3, FSH 1909.15, 06

All of the alternatives have this same structure of action. Each incorporates this five-step process for managing competing and unwanted vegetation. However, each alternative differs in the direction given in different steps.

As noted, the five steps take place within the environmental analysis process. For the purposes of managing competing and unwanted vegetation, they are special points of emphasis: special things that field professionals and managers will consider.

The five steps are familiar to many as parts of environmental analysis ("the NEPA process"), and to others as "the scientific management method". Others know them as the analytical steps used in "integrated pest management". They are commonly used in silvicultural prescriptions and are partly documented in the Timber Stand Improvement Handbook (FSH 2409.26c). They are intended to provide Forest-level direction in implementing the vegetation management portion of any of the nine vegetation management activities covered by this EIS, and described in detail in Appendix G.

Environmental analysis is not a lock-step process. Parts may be done in various order, and some parts may be done several times. The five steps in managing vegetation mesh well with environmental analysis. Much occurs within "scoping", where the scope of the action, its context, and further analyses are examined. Figure II-5 illustrates how the five step vegetation management process fits within environmental analysis.

Details of the Five Steps in Managing Unwanted and Competing Vegetation

Each alternative attaches different direction to different steps; however, all alternatives require this five-step structure of analysis, action, and follow-up, within the established NEPA process. All vegetation management needs to be consistent with the goals, standards, and guides identified in applicable land and resource management plans.

Step One: Site Analysis

A project may be initiated as a result of any of a number of activities planned under the auspices of applicable land and resource management plans, such as proposed timber sales, right-of-way or campground maintenance, or an observed problem such as increasing populations of noxious weeds.

The first step in gathering information is to identify the site and the affected area. Scale is important. The site should be small enough that its ecological systems will respond similarly to treatment; however, when cumulative and synergistic effects are possible, a wider area should be considered.

Specific information gathered depends on project needs and objectives. There are several standard Forest Service inventories designed for specific projects. They are based on years of experience and allow efficient data transfer. They include physical characteristics such as aspect, elevation, and slope. Exams designed for vegetation management, such as "RESERV" used in southwestern Oregon, incorporates an extensive array of biological variables including diameter and height growth rates, cover, and evidence of various types of environmental and animal damage. For a great majority of cases, one of these standard exams would serve this first step well.

The analysis process closely follows the existing environmental analysis process as directed in Forest Service Manual 1950 and Forest Service Handbook 1909.15. As in the current environmental analysis process, the level of analysis, detail, and documentation varies with the scope of the proposed project (see the introduction to this section and Figure II-5).

Analysis includes a description and interpretation of the physical and biological characteristics of the site. It also includes an evaluation of the relationships between the unwanted vegetation and the potential for damage; the consequences and efficacy of alternative actions; the risks involved; prediction of expected results with the chosen course of action; and disclosure of the quality of the information and uncertainty involved in the analysis.

Past practices may affect the site's present performance. When interpreting the site's physical and biological characteristics, emphasis is placed on understanding the potential (rather than current) competition and production.

Production depends on the average condition (for example, the average temperature), but extremes can also have a profound affect on vegetation growth. Both extremes and averages of environmental factors that affect growth and survival should be considered.

Site analysis, analysis of local operational data, and extrapolation of research can be used to establish the damage and action threshold for the project, and to establish the need for action. Yet, in some cases, these relationships may be difficult, or not yet possible, to establish. In such cases, the theme of the alternative provides direction to managers. Alternative G, for example, advises action to reduce potential damage even if not all factors are fully understood.

The potential for environmental damage and health risks are analyzed considering both long and short-term aspects, and methods and strategies are analyzed for their biological and economic effectiveness.

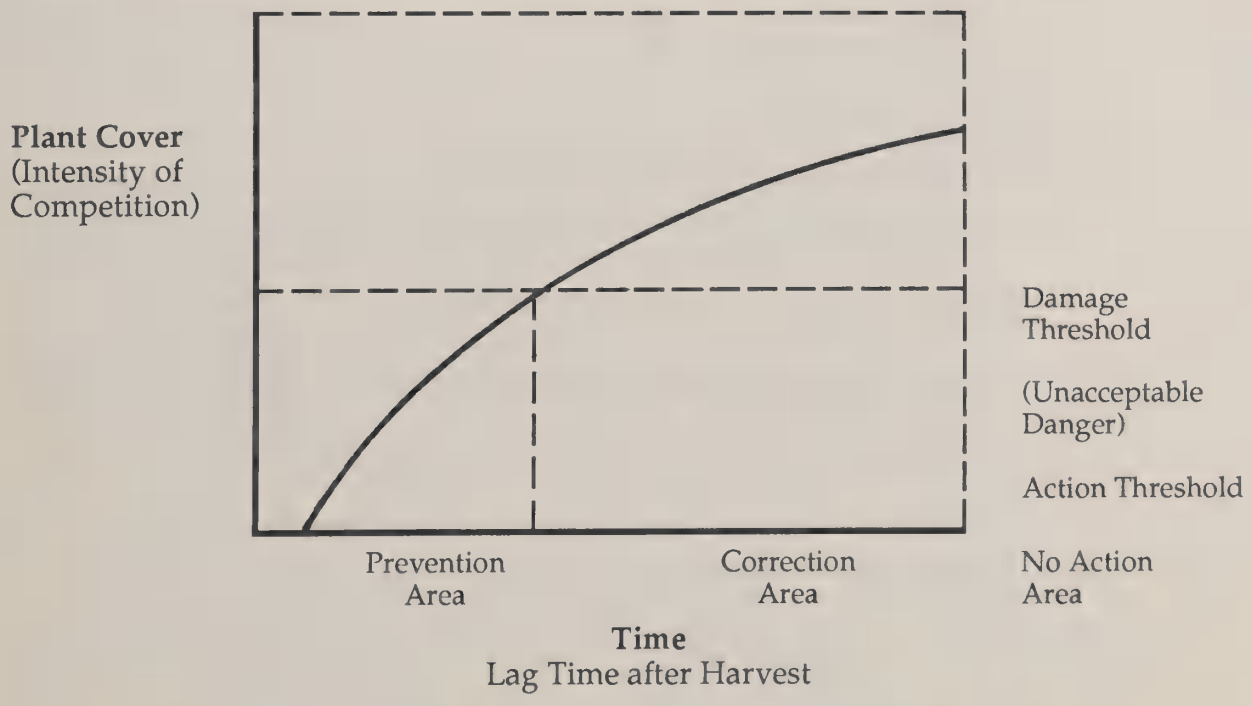
Step Two: Select Strategy

Damage and Action Thresholds

Before describing each strategy, the concepts of action and damage thresholds should be defined, because selecting a control strategy requires knowing what level of damage or competition (if any) is acceptable. The concepts are presented using an example from reforestation of a clearcut timber harvest unit where other vegetation competes with the desired conifers.

Figure II-6 illustrates a typical post-harvest, post-burn condition where the competing vegetation, plant cover, has been reduced significantly.

Figure II–6
Illustrating Strategies and Thresholds in Managing Competing Vegetation



Early sprouting or increases in cover do not provide intense competition. If allowed to grow, however, they may cause unacceptable damage. This level of competition, or damage, is called the "damage threshold." Levels of cover (competition) above the threshold are unacceptable; levels below are deemed acceptable.

In many cases, action is needed to avoid damage. It should be taken sometime before unacceptable damage levels are reached. The time or condition that triggers this action is called the "action threshold."

Thresholds depend on site-specific and species-specific conditions and on Forest goals. Often, these critical points are not known. Although goals (to prevent a specified level of growth loss or damage) may be clear, information on species growth patterns under differing environmental conditions is often lacking, and projects will be implemented under some degree of uncertainty.

The Four Strategies of Vegetation Management

The four general strategies for managing competing and unwanted vegetation are:

- prevention;
- maintenance;
- correction; and
- no action.

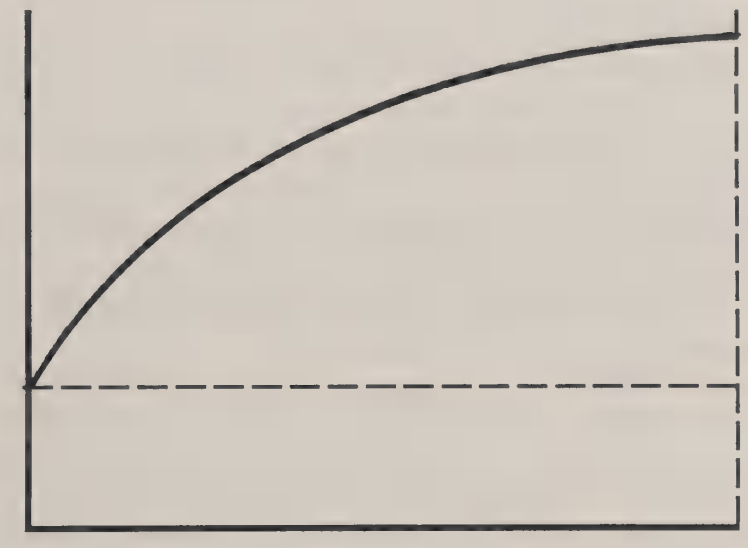
Prevention here means initiating action before unacceptable damage takes place, before the damage threshold is reached (see Figure II-6). Actions are usually applied early, and the action threshold is low. Control of damaging species can be achieved in the early developmental stages, using less energy and (usually) fewer applications. The difference between the damage threshold and the action threshold is usually great, and the relationships between species are usually well understood.

This strategy is common, and appropriate for all alternatives except Alternative C.

Maintenance supports the current condition. Maintenance (keeping the system fine-tuned) may be most appropriate in some programs when stability, rather than cyclic variation, is valued. Examples include maintaining a constant supply of wildlife forage or keeping the noxious weed population under control. The damage and action thresholds are often close, and treatment is usually administered in small, frequent doses. Fine tuning is often all that is necessary. The ecological relationships are usually understood. This strategy is appropriate in all alternatives except Alternative C.

Correction is action taken after the damage threshold has been exceeded. Converting brushfields or hardwood stands to favor conifers is an example of an appropriate use of corrective action., as is the case where a conifer stand is at a point where the level of competition already exceeds the damage threshhold, and unacceptable growth loss is occurring. Figure II-7 illustrates that condition and is essentially the upper right portion of Figure II-6. Correction may also be the appropriate strategy when there is a high degree of uncertainty about the competitive ability of a species. Action may be delayed to monitor and establish a damage threshold. In some cases action may not be necessary; in others, correction may be needed.

Figure II-7



Typical Brush Field Conversion

Information on damage thresholds for specific species on various sites is needed. Some will be provided by research, but site-specific data will be provided by detailed monitoring and record-keeping during and after project implementation. Thus, each project will add to the data base that can be used to establish thresholds, reduce the level of uncertainty, and increase efficiency. Noxious weed control efforts fit well within the four general vegetation strategies displayed here. Specific refinements of the general strategies for noxious weeds are displayed in the noxious weed section of Chapter IV.

Correction strategies usually require high energy and resources levels compared to other strategies. In addition, several treatments may be required to bring damage levels below the threshold.

Correction strategies are appropriate in all alternatives. In Alternative C, correction may be used to correct a situation threatening human health.

No action means no interference with natural processes by humans. Successional cycles, fuel accumulation, growth loss due to competition, and damage due to noxious weeds are accepted along with their indirect effects. This strategy requires little to no energy or resources. It is essentially the theme of Alternative C, and may be appropriate under some conditions when implementing other alternatives.

Using the Strategies

Note that all of the management strategies are being employed in the existing Forest vegetation management programs. These are best approximated by Alternative B. In other words, there is nothing new or revolutionary about concepts such as the development of preventive strategies, nor of no-action prescriptions when damage levels do not exceed tolerable limits. The important variable will be the relative emphasis and priority assigned to each of the general strategies within the context of a given alternative.

For example, under baseline Alternative B, approximately 12 percent of the silvicultural site preparation and conifer release diagnoses result in a no-treatment or deferred treatment decision. Under Alternative D, with added emphasis on caution and a reduced tolerance for data gaps, this would be increased to roughly 28 percent of the diagnoses.

While competing vegetation is often detrimental to conifer growth, certain situations or growth stages may be beneficial (See introductory material in Appendix A).

The decision to treat or not to treat competing vegetation is normally a function of the severity of site competition, as well as of trade-offs between negative and beneficial aspects of the existing or predicted shrub and herbaceous vegetation component.

Similarly, a variety of preventive strategies are presently being employed in silvicultural programs throughout the Region. Under an alternative such as D, however, the relative emphasis and sense of urgency for implementing preventive measures would be increased in comparison with the baseline Alternative B.

Some specific examples of existing prevention measures include:

- the use of seasonal alder cutting "windows" by the Siuslaw and Olympic Forests to inhibit the amount of alder re-establishing on a site, and also to inhibit its vigor
- a Siskiyou National Forest proposal to use systemic herbicides in a tanoak "cut-and-dab" treatment during logging operations, in order to prevent future difficult release problems;
- discing of sedge covered sites during August (when root systems will dry and die) by the Winema National Forest; and
- use of mechanical equipment such as the Forest Cultivator (to establish natural conifer regeneration where the opportunity exists) by the Okanogan and other East-side Forests.

Use of Silvicultural Systems

Opportunities to develop long-term preventive strategies for vegetation management are linked with the harvest cutting methods and silvicultural systems employed. Methods fall into two groups: those producing even-aged stands, and those producing uneven-aged stands. Site-specific prescriptions are the appropriate vehicle for selection of the system that best achieves management objectives. (See the section on the EIS and IPM in this chapter.)

Step Three: Design Project

Good design depends on thorough examination of the site, review of the available research, and complete analysis. A number of elements must be knowledgeably combined to produce a coherent project plan. Some of the elements will be the same regardless of the alternative selected; others will vary by alternative.

Elements involved in design include Forest Service goals, program objectives, project objectives, alternative theme, design criteria, meth-

ods, scheduling, and mitigation (if needed). Forest Service goals, program objectives, and project objectives vary little among the alternatives. Conversely, theme, design criteria, and methods are important variables distinguishing the alternatives.

Design Criteria

The alternative theme and design criteria govern the design of the project. Each alternative emphasizes a combination of the four strategies given above and deals with issues derived from public input by varying the emphasis placed on each of the design criteria (the design criteria reflect issues raised by the public).

Human Health Assurance

The alternatives will vary in the standards required to safeguard human health. Major differences are the degree of risk to forest workers and the general public. For example, in response to concern over public safety, Alternative A prohibits the use of herbicides. However, if manual methods are used instead, there is increased health risk to forest workers.

Environmental Effects

The environmental effects of the methods, tools, and specific techniques are major concerns in all the alternatives. In all cases, impairment of long-term productivity and long-term environmental damage are to be avoided. However, under Alternative G a greater risk of short-term adverse environmental impact on the site is accepted to achieve an increase in commodity output. On the other hand, in Alternative D the risk of adverse environmental effects is of higher concern than commodity output.

Use of Natural Processes

Some alternatives will direct the managers and professionals to design projects and select tools that most closely incorporate and encourage natural ecological processes; others endorse these as well as active manipulation and alteration of these processes.

Economic and Social Effects

In addition to the effects on the physical and biological aspects of the environment, there are also effects to the economic and social parts of the human environment. The alternatives vary in the importance given to positive and negative economic and social effects resulting from the methods and project designs chosen. Some will accept some short-term disruption of economies and communities for long-term biological and physical benefits; others attach greater importance to maintaining economic and social conditions.

Public Involvement

Our goal, working within the guidelines of the NEPA process, is to achieve a public participation process in which interested and affected people are involved throughout our planning and decision-making operations. This process will include:

- using scoping (a NEPA-defined information-gathering process) to assess public involvement needs;
- involving people early and throughout the process, including planning, implementation, and monitoring;
- working with people interested or involved in all types of vegetation management projects;
- continuing to educate and talk with people about Forest Service management; and
- working closely with other agency staffs and cooperators.

As part of the scoping step of the environmental analysis for a project, Forest personnel will assess public participations needs, developing public involvement objectives and plans through contacts with interested and affected people.

This step of the environmental analysis process is critical for developing opportunities for people to participate in our decision-making. It provides initial contacts with people who are interested, and sets the stage for how we will work with people throughout a particular planning effort.

Once the public involvement objectives are developed, regular communication between these people and National Forest employees can be used to initiate changes or adjustments in the overall plan.

The level of interest identified during scoping will determine the extent of the public involvement effort. Based on the scope of a particular project (or set of projects), public interest may be high and opportunities to be involved may be frequent and significant. In other situations, the scoping process may uncover little interest, and the Forest may proceed with simpler and less extensive involvement efforts.

We are striving to assure that people who are interested in specific vegetation management projects will have the opportunity to be involved in the process we use to make decisions.

Vegetation management projects associated with timber management activities have received most of the public attention in the past. We encourage expansion of participation efforts to include a wide variety of vegetation management activities including roadside projects, wildlife and range habitat improvement projects, prescribed burning projects, developed recreation projects, and others.

Special efforts will be made to work jointly with national, state and local jurisdictions when they are affected by our vegetation management planning, or when National Forests are affected by theirs.

We will continue to work towards resource coordination, and towards sharing overall public involvement and participation efforts.

Permitted Tools and Techniques

Some alternatives explicitly prohibit some tools (such as herbicides); others permit selection from a full range of tools and techniques.

Commodity Production Targets

Some alternatives instruct managers to place substantial emphasis on the maintenance of the production of commodities to meet or exceed program targets; others attach less importance to meeting these "output targets" until experience in the wide-spread use of newer vegetation management techniques can be incorporated into the program targets.

Based on predictions made during analysis, some mitigation may be necessary. In many cases, the project can be designed to avoid, minimize, or reduce adverse environmental impacts. If not, rectification or compensation as mitigation are considered.

Mitigation measures are method-specific, not alternative-specific, and can be found following the discussion of methods.

Good overall analysis will uncover the need for mitigation. Proper design will usually satisfy it. However, the project administrator should be alert for further needs during the implementation phase.

A project risk plan should be a part of every project, partly as an evaluation of human health risk, and partly as an evaluation of risks to the environment. Safety plans and spill plans are examples of elements needed in such plans. The plan should be appropriate for the specific project, considering exposure of risks to workers and the general public, and the extent of area covered and the persistence of the methods used.

Step Four: Action

With the analysis and design presented, and the alternatives and effects displayed, the line officer decides on implementation. Training, expertise and accountability will assure that projects are carried out as designed, under specified conditions.

Administrators will pay close attention to unanticipated on-site factors that would increase damage to the natural environment and will be fully aware of the theme and spirit of the design.

Good record-keeping is as important in implementation as in gathering information (step one of the process). It is particularly important if changes are made in the design on the spot. In fact, the monitoring process begins here.

Step Five: Monitoring

Monitoring is assuring that the project is implemented as designed and recording the results. Many of the same variables inventoried during the information gathering phase (step one) are remeasured and evaluated against the predicted results and project objectives.

Monitoring assures that mitigation measures are carried out and may be used to evaluate whether further mitigation is needed.

The information can be used to validate or refine techniques and activities. In some cases, an activity may prove to be unnecessary or may need refinement to produce desired results. Ineffective and costly techniques can be eliminated.

Monitoring may also help to clarify ecological inter-relationships between unwanted vegetation and the environment or between unwanted vegetation and crop trees or other more desirable species.

Most monitoring is done within the project area on target species, crop trees, and nontarget species of concern, such as rare or sensitive species. However, downstream monitoring is common where herbicides are used; stream turbidity may be monitored if mechanical methods are used; and remote airsheds may be monitored when areas are burned.

Monitoring during implementation may be critically important if design changes are made that affect the intensity of application or alter the techniques used. Most monitoring is done immediately after project completion and at appropriate intervals thereafter. If the rate of change is high, as with invasion of annual noxious weeds, yearly

monitoring may be necessary to maintain weed-free rangeland. If change occurs slowly, several years between measurements may be adequate.

The most difficult monitoring will be for long-term effects. The variables measured will be the same, though some may be added in the future. The difficulty lies in assuring consistent measurement of the treated area, and in maintaining complete records through the rotations. Precise identification of the treatment area is essential, particularly where treatment levels varied within a project area.

The EIS and IPM

The use of integrated pest management (IPM) is Forest Service policy; however, specific direction is not detailed in the Forest Service Manual.

This EIS is an integrated analysis developed by an interacting team of specialists. In this chapter of the document you will find outlined a five-step process for managing vegetation that is consistent with the elements of IPM found in most references.

More generally, discussions of the overall management approach (including IPM) can also be found as part of the overall decision-making process detailed in the descriptions of the alternatives (particularly D and H), and in the Implementation section. Our emphasis and approach is presented below.

Most IPM literature relates to artificial systems (particularly agricultural), which use highly developed hybrids or exotic species, and which depend on high energy input such as repeated cultivation, weeding, and fertilization. Many species of plants, insects, birds, and rodents are considered "pests", thus the name Integrated Pest Management.

Most forest settings are ecologically intact and provide ample opportunity to work within a fully functional ecosystem in which plants and animals are regarded as integral components.

Periodic epidemics (much like periodic wildfire) are part of the natural system. Both play an integral role: thus, like wildfires, these epidemics should not always be suppressed. Such events, as part of the natural selection process, ultimately result in diverse and healthy ecosystems.

The word pest in itself introduces a value judgment into the analysis process. In managed systems, the proliferation of so-called weeds or pests is often a sign of the lack of understanding of natural ecosystem dynamics. The most effective and efficient cure may lie in allowing natural processes to remain fully functional.

The five steps—site analysis, select strategy, design project, action, and monitoring—follow the features of integrated pest management.

Of these five steps, commitment to one (monitoring) provides our greatest opportunity to learn, through monitoring natural and man-induced changes in the physical and biological environment. In effect, we are listening to the system to find solutions with the least impact on natural processes.

The process requires full documentation from the planning stage to beyond project completion. Casual observation provides little information, so quantitative sampling (using existing formal exams) is preferred. Data analysis will be used to set appropriate damage and action thresholds for managing changing conditions.

Monitoring and analysis are our main sources of feedback. In addition, research, interaction with practitioners, and discussions with interested and informed members of the public are also useful resources.

Our emphasis on early planning of preventive strategies with the full complement of methods is consistent with most IPM definitions (see the section on selecting a vegetation management strategy in this chapter).

Our greatest opportunities for applying the ecosystems approach and the principles of IPM are outside the scope of merely controlling competing and unwanted vegetation. Opportunities in silviculture include variation in harvest practices, species mix selection, and stand density management. Rangeland managers have long been aware of the effects of grazing systems on native vegetation and the spread of noxious weeds. Engineers are becoming aware of design elements that not only decrease the need for controlling vegetation but actually use vegetation to decrease total maintenance costs.

Implementation will result in strong analysis, cost-effective treatment, low human health risk, and a healthy, resilient ecosystem.

Use of Silvicultural Systems

Opportunities to develop long-term preventive strategies for vegetation management are obviously linked with the basic harvest cutting methods and silvicultural systems employed. Methods fall into two groups: those such as clearcut, shelterwood, and seed tree systems that produce even-aged stands, and those such as single-tree or group selection that develop and maintain uneven-aged stands. Site-specific prescriptions are the appropriate vehicle for selection of a system which will best achieve management objectives.

Silvicultural systems are difficult to characterize because of the diverse harvest systems, environmental conditions, and silvicultural strategies now being employed in the Pacific Northwest Region. Even-aged methods are the most commonly employed prescription for the intensively managed (full-yield component) suitable timberlands under the proposed Forest land management plans.

Uneven-aged methods are viable when healthy, fully stocked, uneven-aged stands exist or can be created within a reasonable time frame. Harvest cutting methods are often restricted by factors such as the need to protect vegetation for stream temperature control, wildlife habitat needs, maintenance of soil productivity, riparian areas, and visually sensitive areas where there is a need to maintain a "high-forest" appearance.

Selection of the silvicultural system is a fundamental step in the process for managing competing vegetation. The decision must be made within the context of direction provided in an approved land management plan, and in the 1984 Pacific Northwest Regional Guide. The Regional Guide provides criteria for selecting silvicultural systems.

Selection of a harvest cutting method is often influenced by site-specific stand regeneration considerations. A case in point is the effort to employ multi-aged forest management during the early 1970s in mixed conifer stands on several Forests within the Siskiyou Mountains Province. Partial cutting was employed on steep slopes on which hardwoods and sprouting shrubs are a relatively low level (but constant) component of many existing unmanaged stands. The partial cutting, in most instances, led to stands which were understocked and badly damaged during felling and yarding operations, encroached with sprouting shrubs and germinating weed seed loads, and presented little opportunity for effective site preparation. The end result was to exacerbate an already difficult timber stand regeneration problem.

Chapter 2
The Alternatives

Methods and Mitigation Measures

Mitigation Measures and Vegetation Management Methods

This section presents the mitigation measures used to avoid or reduce potential environmental impacts. They are presented in the context of the five "methods" used to manage competing and unwanted vegetation.

The five general methods of managing competing and unwanted vegetation are:

- biological/cultural/grazing: the use of pathogens, insects, plants, or animals for control;
- prescribed burning: the managed use of fire;
- manual: the use of hand-held tools (includes power tools);
- mechanical: the use of tractors or other large machines; and
- herbicides: the use of herbicides (aerial and ground).

Mitigation measures are designed to reduce, avoid, minimize, rectify, or compensate for impacts on the environment which might result from vegetation management activities. The mitigation measures incorporated here draw from the existing direction found in Forest Service manuals and land and resource management plans, information in the research literature, and the accumulated field experience of Forest Service professionals.

Several mitigation measures will apply regardless of the alternative selected or the vegetation management method employed. These common mitigation measures are listed below.

Most mitigation measures, however, are applicable to a specific method, and will be presented following the discussion of the relevant method.

In addition, certain specific restrictions or changes in management have been built into the alternative description themselves. These are mitigation measures that apply only to that specific alternative. Examples include the prohibition of 2,4-D, amitrole, diuron, and fosamine in Alternative E, and the restrictions on slash burning in Alternatives F and H.

Chapter IV presents the environmental consequences of the alternatives assuming the mitigation measures are followed. The chapter also provides information on the effectiveness of the mitigation measures.

Mitigation measures for the use of fire and herbicides are more numerous and detailed than for the other methods. This is due to the public interest directed toward these methods during the development of the EIS.

Prescribed fire and herbicides are used in managing National Forest lands and resources only as ways to control competing and unwanted vegetation. Manual, mechanical, and biological methods are used in other activities including timber harvest, road construction and fire fighting. Direction (summarized in this document) governing use of these methods in these other activities apply when they are employed for managing competing and unwanted vegetation.

Mitigation Measures Common to All Methods and All Alternatives

The following mitigation measures will be applicable to all methods of managing competing and unwanted vegetation, and are common to all alternatives.

The first three measures apply to silvicultural activities (site preparation for planting and conifer release from competing plants).

Silvicultural activities will employ the following mitigation measures for all methods:

1. A documented prescription will be prepared or approved by a certified silviculturist. Diagnosis and prescription will follow direction in Forest Service Handbook 2409.26d (Silvicultural Examination and Prescription Handbook). Prescriptions include five elements:

    - description of physical and environmental conditions;
    - description of biological conditions;
    - statement of management objectives;

- consider treatment alternatives, as well as a recommended treatment; and
- identify monitoring requirements.

Prescriptions should recognize the forest as an ecosystem, be sensitive to the quality of data used, and objectively analyze how well an action would meet management objectives. A no-treatment or deferred action will be considered in all diagnoses.

2. Site-specific diagnosis and analysis will meet standards established in Forest Service Handbook 2409.17, (Silvicultural Practices Handbook). Knowledge and skill levels for certified silviculturists are defined in Chapter 8 of this handbook.

   Standards defined in FSH 2409.17 will be met for project evaluation, implementation, and monitoring.

   Monitoring will be designed to determine whether:

   - prescription and management objectives have been met;
   - remedial treatment is necessary; and
   - findings can be used to strengthen future prescriptions.

3. The Guidance for diagnosis and determination of treatment need which is contained in Forest Service Handbook 2409.26c (Timber Stand Improvement Handbook, Chapter 10) will be consulted. This handbook includes direction for the determination of objectives for vegetative response and the establishment of time frames.

   Evaluations of treatment methods must consider effectiveness, viability, and efficiency. The value of early plant community monitoring and maintenance in order to help reduce the magnitude of future release needs should be recognized.

   Additional mitigation measures will be employed for all management activities.

4. Scoping and environmental analysis will be conducted for each proposed project. This analysis will follow guidance in Forest Service Manual 1950 (Environmental Policy and Procedures) and Forest Service Handbook 1909.15 (Environmental Policy and Procedures Handbook).

Potential adverse effects, including those to soils, long-term productivity, water and air quality, vegetative diversity, wildlife, fish, and threatened, endangered, or sensitive species will be evaluated. The potential for cumulative impacts of past and proposed projects will be considered during Forest or project-level environmental analysis, and will be mitigated where possible.

5. Each project proposal will include a Human Health Risk Management Plan. As appropriate, this may include elements such as:

   a. Project Risk Plan—includes the identification of personal protective equipment, special orientation and training needs, hazard identification, first aid training or supplies, and safety meeting schedule. The basic reference is Forest Service Handbook 6709.11 (Health and Safety Code Handbook). Medical support facilities, as well as accident investigation and reporting responsibilities will be identified.

   b. Environmental Monitoring Plan—includes water monitoring procedures and standards, requirements for notification of adjacent landowners or forest visitors, and record-keeping needs.

   c. Spill Incident Response Plan—for projects involving movement or handling of hazardous materials. This plan will identify responsibilities, notification procedures, and containment or cleanup measures.

   d. Prescribed Burning Plan—states specific, quantifiable effects (duff/litter consumption, plant and debris removal), pre-burn weather and fuel moisture monitoring plan, burn prescription (wind, fuel moisture, etc.), escape contingency suppression plan, required coordination, special smoke management needs, and documentation (monitoring and evaluation) procedures and responsibilities.

   e. Herbicide Application Plan—this will identify organization and support needs, calibration procedures, equipment inspection procedures, communications needs, search and rescue procedures, batching procedures, public contact procedures, posting and signing needs, and herbicide accountability standards. Special precautions for applicators, mixers, and loaders will also be identified.

   The size and complexity of each vegetation management project, along with the specific methods and techniques employed,

will define the content of a project Human Health Risk Management Plans. The design of every project, however, will consider the health risks for workers and the public, and will identify contingencies in the event of accidents or incidents.

6. Training, direction, and quality control will be provided at all administrative levels–the Regional Office, National Forests, and Ranger Districts. The purpose is to help project planners, administrators, and managers perform their responsibilities effectively and efficiently. Training and orientation will be used to develop a common understanding of management objectives, restraints and mitigation measures, and concepts necessary for the implementation of the vegetation management program.

   Forest Pest Management, along with the program managers and staff groups, will be responsible for providing training and monitoring to assure that:

   a. project planners and decision-makers will acquire a working knowledge of the process for managing competing vegetation (Chapter II); and

   b. information exchange takes place when new or modified vegetation techniques, methodologies, or monitoring strategies that show potential for more widespread use are developed

   While training is a major element of all alternatives, the content and emphasis would vary between alternatives. For example, alternatives D and G incorporate some shift in management emphasis in comparison with Alternative B. This means that training would be geared toward the understanding of some new concepts or restraints in order to implement these alternatives. Likewise, added restraints on the use of herbicides are incorporated into Alternative E, and would be reflected in training efforts during the implementation of this alternative. Under all alternatives, however, training, orientation and quality control will be required for the successful implementation of the desired vegetation management program.

Descriptions of the five methods of managing competing and unwanted vegetation are presented here, followed by the mitigation measures specific to each method.

Biological, Cultural, and Grazing Methods

Generally, biological methods include the use of pathogens, parasites, and insects to control vegetation. The intent of biological control is to introduce and manage the natural enemies of a weed. Most biological control agents (BCAs) - about 50 percent - for noxious weeds feed on the flower heads. Other biological control agents feed on the crown and stems (19 percent), leaves (17 percent), and roots (14 percent). (R.Brown, Oregon Department of Agriculture, personal communication.)



Grazing animals and leaf-eating insects are the most commonly used biological methods of vegetation management.

The selective release of insects has been used to weaken or kill specific target plants in certain noxious weed situations. These biological control efforts require close coordination with state agencies and county weed control programs, as well as with federal agencies, including the USDA Agricultural Research Service. Initial introductions of the biological control agents are obtained through the USDA Biological Control Laboratories. Management of the biological control agents and subsequent releases are handled from biological control agent nursery sites in a state. Biological controls can be effective when the population of target plants is large enough to support the insects or nematodes, and when adequate numbers of insects can be obtained.

Insect adults and larvae can damage noxious weeds by feeding on seeds and leaves, girdling roots, and forming galls. Efforts are normally made to harvest the insects for redistribution purposes. Selective release programs have a history of success in local situations, such as the control of St. Johnswort and tansy ragwort. A great deal of research effort has been directed toward this technique in recent years.

The disadvantages of this biological vegetation management technique are the intensive monitoring efforts required and the difficulty of obtaining insects. While the introduction of host-specific insects is carefully studied and planned in advance, there is always the potential risk of disrupting natural ecosystems. This risk has been minimized by using host-specific control agents, careful suitability studies, and intensive monitoring. To date, there are no examples of any harm done to natural ecosystems by biological control agent introductions for noxious weed control.

Some examples of host-specific insects successfully used in the Pacific Northwest to control target vegetation include the flea beetle and cinnabar moth (tansy ragwort); seedhead weevils (yellow starthistle); root and stem boring moth larvae (Canada thistle and Scotch broom); and seedhead flies (diffuse knapweed). A complete listing is provided in Appendix G.

Several biological techniques show promise in the experimental stage, but are not yet operationally proven in forestry. These include:

biological herbicides—naturally occurring microbial or viral agents similar to those which have proven effective in insect control and agriculture; and

pathogens and allelopathy—use of introduced pathogens and chemicals produced by plants to repel or inhibit competitors.

Prolonged or forced grazing of domestic livestock (cattle and sheep) can be used to control the composition or amount of competing vegetation. This differs from the typical grazing program in that vegetation control, rather than animal weight gain or forage utilization, is the primary objective.

Livestock use can be considered when preferred or palatable species are a significant component of the vegetation, and when an area large enough to support the herd or band is available for management. Careful coordination with range and wildlife habitat management goals is required.

Grazing can have several advantages. In the proper mix of brush, weeds, and grasses, grazing can effectively control the vigor of undesirable vegetation. Grazing can be cost-effective and may often be done in conjunction with existing range permits. On some nutrient-deficient sites, the animals can be beneficial because they convert vegetation directly into an available source of nitrogen.

Several disadvantages of grazing must also be recognized. Timely project administration and experienced herders or riders are needed to control the duration and intensity of use. This is particularly true with sheep movement and bedding. Conifer seedlings can be susceptible to browsing or trampling damage, especially during the spring season. Livestock must be strictly controlled within riparian areas or on soils subject to compaction in order to prevent damage to soil and water resources.

Water distribution and availability can limit the effectiveness of livestock use for vegetation management purposes. The quality and quantity of forage for its nutritional value will also affect the value of livestock grazing. Access to a site and control of livestock numbers by herding and fencing will contribute to the effectiveness of this technique.

Experience has shown that willing operators are not plentiful. In order to obtain a release effect in conifer seedlings, or to significantly reduce undesirable vegetation, livestock must be held in an area much longer than normal. Forced grazing such as this can adversely affect animal weights and marketability, which is a serious problem for many stockmen.

Livestock have been effectively used to control competing vegetation in the rangeland rehabilitation programs on the Forests of eastern Washington and Oregon. Sheep and cattle have also been used effectively for conifer plantation maintenance. Specific examples of successful livestock use on an operational basis can be found on the Fremont and Siuslaw National Forests.

Seeding with desired species is a preventive technique used on newly disturbed sites such as roadsides and other rights-of-ways. Timely seeding of low-growing grass or brush species, often accompanied by fertilization, may inhibit later invasion of the site by taller shrubs and trees. Once a stable plant community is established, the site becomes self-maintaining. More research is needed in a variety of site conditions to determine which species are successful under what conditions.

Seeding of desired species (genetically adapted species) or the use of natural and advance regeneration stock can be used successfully in certain situations.

Through the Regional genetics program, the technique of genetic adaptation is being explored. Trees with the potential for fast, early

growth are selected to be used as a seed source. The use of stock developed from these seeds may limit the need for conifer release in some situations. So far, the program has been limited to a few commercially important species. However, as results are evaluated, more species may become used for specific site needs.

Taking advantage of natural seedlings and advance regeneration (established trees from the previous stand) can, in some cases, reduce the need for competition control. Natural seedlings go through a rigorous natural selection process, and are uniquely and specifically adapted to the site. There are usually a number of different species present, adding to the diversity and increasing the chances for survival of a healthy stand. In many cases, they grow faster than the planted trees.

Using advance regeneration has the same advantages as using naturals, but their older age and larger size can give them a significant advantage over the competition. However, stands composed of advance regeneration trees can be diseased, suppressed, or damaged, and do not always represent a positive opportunity.

Uneven and multi-aged forest management may present some options when used in a manner consistent with site and management requirements. Removing selected age classes may not allow the competitors to gain dominance on a site, since many brush species require full sunlight for optimum growth. The remaining crop trees expand to take advantage of the newly available resources left after harvest.

In order to minimize soil disturbance and damage to the residual stand in an uneven-age management regime, the terrain must be gentle. Otherwise, long-term damage caused by multiple entries would far outweigh the benefits to vegetation control. The Region and Forests have standards and guidelines dealing with the selection of harvest systems.

Biological, Cultural, and Grazing Mitigation Measures

1. All Forest Service uses of biological control organisms will be in cooperation with the USDA Agricultural Research Service or under individual, approved state programs.

2. Project planners will inform downstream water users who could be directly affected by biological contamination of surface water.

3. Existing direction found in Forest Service Manual 2200 (Range Management) and Forest Service Manual 2500 (Watershed Management) provides for protection of resources during livestock grazing. Standards and Guidelines in Forest land management

planning documents address local conditions and measures necessary to minimize impacts on soils and vegetation due to trampling by livestock.

Livestock will be strictly controlled in the vicinity of wetlands and riparian areas to prevent trampling and compaction of wet soils, water contamination, and destruction of riparian vegetation and streambanks. Specific management direction for protecting riparian areas, wetlands, and threatened, endangered and sensitive plants is found in the applicable land and resource management plans. Management techniques could include fencing, herding, sale distribution, and herd adjustment.

4. The consequences of using genetically adapted seedlings selected for fast, early growth will be evaluated for their long- term effect on the diversity of natural forest and range ecosystems. The evaluation should occur as part of the Regional -level genetics program.

Prescribed Burning Methods

Prescribed burning is the intentional application of fire to forest and rangeland to accomplish specific, measurable management objectives. For the right situation, prescribed burning has many advantages over the other vegetation management methods: it can be environmentally compatible and more cost-effective. Indeed, for the restoration and preservation of fire-dependent and seral plant communities, prescribed fire is the only method.

Fire, under predetermined conditions, can be used in some circumstances to achieve land management objectives.



Like the other methods, prescribed burning also has disadvantages. Fire is marginally selective. The effects of fire, particularly on microorganisms and many plants are not known; and the desired effects are not always achieved as they depend on the fire burning within a narrow behavioral range. How long an effect lasts depends upon each species' heat tolerance , vigor, ability for sprouting, and the sensitivity of its seeds.

If too much vegetative material is consumed, unacceptable floral mortality will occur, and the soil will be damaged; water quality may also be affected. The smoke from prescribed fires pollutes the air, and a prescribed fire may escape and cause unacceptable damage.

More information on prescribed burning effects is presented in Chapter IV, Environmental Consequences.

Prescribed Burning Techniques

There are three prescribed burning techniques: broadcast burning, pile burning, and underburning.

Broadcast burning is the burning of natural and activity-generated vegetative residues, scattered over an open area such as a clearcut. Broadcast burns are usually ignited with hand-held drip torches; helitorches are becoming more widely used. A helitorch is a device suspended from a helicopter that "drips" flaming jellied gasoline. Helitorches are used where it is necessary to ignite an area rapidly, or when it is unsafe for workers on foot to do the lighting. Rapid ignition makes it possible to burn at higher fuel moistures, thereby reducing smoke and the danger of escapes.

Mechanical pre-treatment is often done in combination with broadcast burning. For example, brush or saplings may be cut and scattered prior to burning. Logging residues may be crushed and compacted to reduce fire intensity and rate of spread. Material may be "YUM-ed" (yarding of unmerchantable material) from the unit; YUM is done with skidders or cable logging machinery.

Pile burning of forest residues is done in conjunction with "PUM" (piling of unmerchantable material) and "YUM" to concentrate slash into piles or windrows. PUM is done manually or with a tracked or rubber-tired tractor.

Generally, piles and windrows are burned in the fall after snowfall or rain to minimize the risk of escaped fires. This levels the burning workload and the impact on air quality. The most commonly used

devices for igniting piles are hand-held drip torches and alumagel packets. Alumagel is a gasoline thickening agent. The jelled gasoline is put into plastic bags, placed inside the piled slash, and ignited electronically.

The soil under a burned pile is often sterilized. Sterilization results from the persistent and high soil temperatures resulting from the long fire residence time characteristic of the stationary pile fire.

Underburning is burning beneath an overstory to reduce woody debris, set back unwanted vegetation, or to encourage the growth of desirable forage and browse plant species. The hand-held drip torch is used to ignite an underburn. Underburning is done when the air temperature is relatively cool and there is sufficient wind to dissipate the convective heat, which would otherwise damage the overstory. Relatively high duff/litter moisture contents are prescribed to limit forest floor consumption.

Prescribed Burning Mitigation Measures

For each project, the Forest Service requires a written, site-specific prescribed burning plan approved by a line officer. The purpose of the plan is to ensure that resource management objectives are clearly defined and that the site and environment are not harmed. A prescribed burning plan must include:

1. Description of the burn unit and the primary reasons for the burn (site preparation, hazard reduction, deer habitat improvement, etc.).

2. The range of acceptable results expressed in quantifiable terms (reduction of the loading(s) of specific fuel class(es); numbers of planting sites; stimulation of growth of specific food plants, etc.).

3. The burning prescription: includes weather and fuel moisture criteria that will produce the results specified in number 2 above; and fire behavior that will enable the burning crew to maintain control.

4. Pre-burn monitoring: describes how and where the fuel moisture and weather conditions will be monitored to determine when they are within prescription; indicates which elements are to be monitored.

5. Preparation needed for burning: specifies the location of fire breaks, hose lays, and other tasks required to prepare the site for burning.

6. Risk assessment: quantifies the chance of fire escape and the range of possible consequences. Contingency actions to be taken if there is an escape - whom to call, control line location, etc.

7. Provision for pre-burn coordination: notification of regulatory and cooperating agencies and the affected public.

8. Smoke management: identifies roads, airports, communities, residences, recreation sites, and scenic areas that must be protected from smoke; specifies procedures and conditions that will protect the environment and the health and interests of the public.

9. Safety and protection of improvements and fire-sensitive features: lists health and safety hazards; things, areas, etc. that must be protected.

10. Firing, mop-up, and patrol procedures: specifies exactly how the burning will be done.

11. Documentation: includes monitoring of smoke and fire behavior and crew actions during the burn; post burn evaluation of results for comparison with the burn objectives.

In the development of prescribed burn objectives and the burn prescription, special attention is given to the following guidelines to prevent soil damage and degraded water and air quality.

1. Extreme care will be taken to avoid consuming more of the residues and forest floor (litter and duff) than necessary to meet burn objectives. This will protect the physical and nutrient properties of the soil. Extreme care will be practiced when burning on steep slopes and on granitic or volcanic soils which are highly erodible.

2. An unburned buffer of vegetation along streams will be maintained to protect riparian vegetation and reduce sedimentation. Care will be taken to limit the severity of the burn in and along intermittent streams. Specific directions for protecting riparian areas and threatened, endangered, and sensitive plants are found in Regional Guides and individual Forest Plans.

3. Protection of visibility in Class I areas and the overall air quality is an important objective. All prescribed burning will be done in accordance with all state and local air-quality regulations. Special care will be taken to prevent smoke from affecting the visibility in Class I areas during periods of high visitor use.

4. Prescribed burning will be planned to avoid smoke intrusion into smoke-sensitive areas identified in the Oregon and Washington Smoke Management Plans.

5. To protect the visibility in Oregon Federal Class I areas, burning on non-visibility impaired days is prohibited in the Cascades from July 4 to Labor Day. There are several exceptions:

   - when the burning is for research;
   - if the mountain tops are covered with clouds;
   - small test burns to aid in developing burning prescriptions;
   - when hardwood conversion is the purpose; and
   - above 5,000 feet elevation on the Willamette National Forest;
   - south of the Calapooya Mountains Divide in southern Oregon.

   All burning will be conducted in accordance with the Oregon Smoke Management Plan which has designated all pre-1984 Cascade wildernesses and Crater Lake National Park as "smoke-sensitive" areas.

6. The Forest Service will comply with visibility protection guidelines for Washington's Federal Class I areas during "visibility important days" from July 4-Labor Day in accordance with the Washington Smoke Management Plan.

7. The "best available technology" will be used to reduce smoke, taking into account other land management practices and costs, as determined on a case-by-case basis. The "best available technologies" applicable to prescribed burning include, (but are not limited to:

   removing (utilizing) woody material;

   reducing felling breakage (cable/directional felling);

   rigorous mop-up of prescribed burns;

   rapid (mass) fire ignition; and

   burning only during optimum conditions.

8. Vegetation treated with herbicide will not be burned for at least one year.

Manual Methods

Manual methods utilize hand labor to remove competing vegetation or noxious weeds, or to modify the immediate environment so favorable conditions exist for desired plants.

Techniques

Scalping during planting is one of the most commonly used manual methods. A small area is cleared with a hand tool to remove potentially competing vegetation in the vicinity of the planted tree. Mulching (with paper, plastic, or other materials placed on the ground surrounding the tree to prevent moisture loss) or the growth of species that compete with the target species are rarely practiced.



Hand labor is sometimes used to remove competing vegetation or noxious weeds, or to modify the immediate environment to favor desired plants.

Power saws are commonly used to achieve release objectives. Competing brush is cut, allowing the crop tree more space and resources to grow. Use of power saws for release has increased since suspension of herbicide use in the Region. Hand pulling of weeds or small competing seedlings, and girdling (removing a band of bark from around the stem) is occasionally done for conifer release. Hand pulling is frequently used at recreation and administrative facilities, tree nurseries, and occasionally along roadsides, where noxious weeds commonly invade.

As in all methods, timing of manual operations is critical. For example, the ability of brush to resprout is partly dependent on when it was cut, and the effectiveness of pulling is dependent on the timing of germination.

The advantage of hand methods is their specificity and low impact on the soil surface. Particular species can be targeted. In riparian areas, and sites with sensitive plants, hand methods assure that only target species are treated.

The major disadvantages of manual methods are their lower production rates, higher costs, and in the case of release, resprouting. Because the root system remains intact, except after hand pulling, the plant retains its vigor and can quickly reoccupy the site.

Working on steep slopes with poor footing, in dense or tall brush, and during exposure to exhaust and gas vapors are potential health risks. Chain saws are dangerous if used unsafely. Available information on risks to the worker is presented in the discussion on health risks (Appendix H).

Manual methods are extensively covered in the Reforestation Handbook (2409.26b) and the Timber Stand Improvement Handbook (2409.26c).

Manual Mitigation Measures

The following mitigation measures apply to all alternatives which utilize manual methods of vegetation management.

1. When manual methods are considered, an analysis of worker exposure to potential hazards and risks will be made. Safety of workers and the potential for serious accidents will be evaluated, and mitigated where practical.

2. As with other methods, a Project Risk Plan will be developed. Items considered should include (depending on the technique used):

   —physical dangers (for example, falls, sprains, or danger from snags);

   —exposure to exhaust gases, dust, or temperature extremes;

   —exposure to vapors during mixing of fuels;

   —risks of being cut; and

   —exposure to poisonous plants, snakes, or insects.

Mechanical Methods

Mechanical methods of vegetation management involve the use of machines to remove or reduce the cover of competing or unwanted plant species.



In mechanical methods of vegetation management, machines are used to remove or reduce competing or unwanted plant species.

Techniques

Crawler tractors or low ground pressure tractors outfitted with various types of blades or mowing attachments are the most commonly used techniques. Site preparation is most often accomplished using various types of blades to remove plants, their roots, and, sometimes, part of the top layers of soils. The technique is named for the extent of the activity. Preparing spots is called scalping; plowing a strip is called furrowing or contouring. In some cases, most of the area is prepared.

Tractors are also used to pile unmerchantable material which may present a fire hazard or create difficult conditions for reforestation. Tractors with attached discs or chains are also used to remove unwanted vegetation for range improvement. Graders, tractors, and other machines use attached brush cutters for roadside brush control.

Cable systems are also used to yard unmerchantable material which may present a fire hazard or create an obstacle to tree planting.

As with all other methods, the timing of application can affect the success and efficiency of the operation when using mechanical methods. Application is usually timed to avoid sprouting and high soil moisture content.

The advantages of mechanical methods are the low costs and high efficiency (in many cases, the plant, roots and all, is removed).

The intense disturbance of the site is the major disadvantage of mechanical methods, particularly during site preparation. Most techniques are nonselective and remove nontarget plants. There are slope and topographic limitations, except with cable systems, and there is usually some resprouting if the whole plant is not removed.

Mechanical methods, tools, and techniques are extensively covered in the U. S. Forest Service Reforestation and Timber Stand Improvement Handbooks (2409.26b and 2409.26c, respectively).

Mechanical Mitigation Measures

The following mitigation measures apply to all alternatives that utilize mechanical methods of vegetation management. Individual Forest land management planning documents provide direction which may be more restrictive in local situations. The following are examples of existing Regional direction designed to minimize soil compaction and erosion during the operation of heavy equipment.

1. Tractors (both rubber-tired and crawler) are prohibited on slopes exceeding 35 percent, except at designated locations (approved by a soil or water specialist) where significant, adverse impacts can be avoided.

2. Tractors are prohibited on critical soils, such as those with high compaction potential, except at designated locations (approved by a soil or water specialist) where significant, adverse impacts can be avoided. A minimum of 80 percent of an activity area should be left in a condition of acceptable productivity potential for trees and other managed vegetation (see Forest Service Manual 2520, 9/83 R-6 Supp. 45).

3. Tractors are prohibited on soils with high erosion and sedimentation hazard in municipal watersheds.

4. Tractors may be limited to operating only during certain periods in order to maintain long-term productivity of forest and range soils. Timing of operations will be based on soil moisture content and soil properties in order to reduce compaction. The advice of a soil scientist will be sought in determining limited operating periods.

5. Protective buffer strips along streams, lakes, and wetlands will be maintained to create a filter mat to minimize off-site sedimentation. Interpretations of site-specific conditions by hydrologists or soil scientists will be used to determine the width

required to prevent accelerated sedimentation. Individual Forest land management planning documents specify standards and guidelines for management of riparian areas.

6. Slash created as a result of mechanical methods of vegetation management will not be piled within the zone of high water flow in stream channels.

Herbicide Methods

Herbicides are used in a variety of activity areas to control competing and unwanted vegetation. All herbicides considered for use are registered by the U.S. Environmental Protection Agency. Treatments are made within manufacturers' label restrictions and agency administrative directions. Herbicides are most often applied in mixtures with water or oil carriers; various adjuvants (wetting agents, sticking agents, stabilizers or enhancers, thickening agents, etc.); or dyes needed for environmental monitoring. A discussion of application rates, modes of actions, and product formulations is found in Appendix C (Herbicide Use and Efficacy).

Sixteen herbicides are being considered for use:

Generic Name	Common Trade Names *
2,4-D	Weedone, Esteron, DMA-4, Formula 40, others
Glyphosate	Roundup, Rodeo
Picloram	Tordon, Amdon
Triclopyr	Garlon
Atrazine	AAtrex
Dalapon	Dowpon M
2,4-DP	Weedone 2,4-DP, Weedone 170, others
Hexazinone	Velpar
Fosamine	Krenite
Dicamba	Banvel, Banex
Asulam	Asulox
Diuron	Diuron, DMU, Karmex, Krovar
Simazine	Princep, Aquazine
Amitrole	Amitrol-T, Amizol, Weedazol
Bromacil	Hyvar, Urox B
Tebuthiuron	Graslan, Spike

* Trade names are registered trademarks.

Techniques

Four techniques of herbicides application are used:

1. Aerial application, using helicopter or fixed wing aircraft.
2. Mechanical equipment, using truck-mounted or truck-towed wand or boom sprayers.
3. Backpack equipment, generally a pressurized container with an agitation device.
4. Hand application by injection, daubing cut surfaces, and ground application of granular formulations.

Herbicides can be highly selective and effective in reducing the cover and competitive effects of target vegetation. In many cases the effects are relatively long lasting. The translocated systemic chemicals can effectively minimize sprouting or rapid site reoccupancy. The major advantages and disadvantages of aerial and ground application are presented below.

Table II-15

Frequency of Herbicide Use by Activity and Application Method

Method	Site Preparation and Release	Noxious Weeds and Range Management	Right-of-Way Maintenance	Recreation Site and Facilities
Aerial				
Helicopter	Common	Occasional	Occasional	None
Fixed-Wing	Rare	Occasional	Rare	None
Mechanical	Occasional	Occasional	Common	Rare
Backpack	Common	Occasional	Occasional	Common
Hand	Occasional	Rare	Rare	Occasional

The major advantages of aerial application are their relative cost efficiency, accomplishment of large acreages in a short time period, the ability to take advantage of target vegetation growth patterns (periods when the target species are susceptible and the crop species is not), and the low impact to the soil surface.

Potential hazards such as unacceptable drift or damage to desirable vegetation, and pesticide handling are addressed in Chapter IV (Environmental Consequences) and will be covered in the project Environmental Analysis Report.



Herbicides-applied via aircraft, overland vehicles, backpack sprayers, or scattered by hand-can be highly selective and effective in reducing competition from target vegetation.

Herbicide Mitigation Measures

The following mitigation measures apply to all alternatives which involve the application of herbicides for vegetation management. They meet or exceed the intent of state forest practices acts.

1. Down-stream water users and adjacent landowners who could be directly affected by chemical drift, stream transport, or an accidental spill, will be notified (normally 15 days) prior to the chemical application.

2. All applicable state and federal laws, including the labelling instructions of the Environmental Protection Agency, will be strictly followed.

3. The herbicides amitrole, diuron and fosamine will not be used in the Region's vegetation management program.

4. The herbicide dalapon will not be used in roadside vegetation management nor in any other situations where its use could result in exposure to the public either through routine operations or accidents.

5. Female workers (either Forest Service employees or contract workers) will not be used as mixers or loaders in atrazine or bromacil applications.

6. Female workers (either Forest Service employees or contract workers) will not be used in backpack spray or hack-and-squirt operations for 2,4-D, glyphosate, dicamba, tebuthiuron, triclopyr, simazine, and bromacil.

7. Female workers (either Forest Service employees or contract workers) will not be used in applications of dalapon.

8. The herbicide atrazine will not be applied aerially.

9. Diesel oil will not be used in herbicide applications. except as an adjuvent (not to exceed 5 percent of spray mixture.

10. Kerosene will not be used in herbicide applications, except as an inert ingredient in the esther formulation of triclopyr.

11. Herbicides will be applied within the prescribed environmental conditions stated on the label, in the environmental assessment, and in issued permits. This includes considerations of wind speed, relative humidity, air temperature, chemical persistence, and time since the last rainfall when determining the timing of application in relation to drift reduction.

12. Use herbicide formulations that contain only inerts recognized as generally safe by EPA, or which are of a low priority for testing by EPA. Use of other inerts (identified by EPA as a high priority for testing or those that have been shown to be hazardous) requires full assessment of human health risks incorporated into the NEPA decision-making process.

13. Protective clothing will be worn by all workers (both Forest Service employees and contract workers) involved in herbicide mixing, loading, backpack applications, and hack-and-squirt applications.

14. Public notification will be used for all applications, requesting that people who know or suspect that they are hypersensitive to herbicides contact the Forest Service office proposing the project to determine appropriate risk management measures.

15. Workers (both Forest Service and contract) who know that they are hypersensitive to herbicides will not be used for application projects. Workers who display symptoms of hypersensitivity to herbicides during application will be removed from the project.

16. Precautions will be taken to assure that equipment used for storage, transport, mixing, or application will not leak herbicides into water or soil.

17. Areas used for mixing herbicides and cleaning equipment shall be located where spillage will not run into surface waters or result in ground water contamination. Whenever practicable, mixing areas and heliports will not be located within domestic or municipal, fish hatchery, or irrigation supply watersheds.

18. Drift of herbicide vapors or sprays will be minimized to within the prescribed buffer strip boundaries. The goal is to optimize droplet

size to meet control requirements and to reduce risk of contamination due to drift. For aerial applications, fine droplets will be kept to a minimum by techniques such as 1) reducing boom pressure, 2) increasing orifice size, 3) orienting nozzles parallel to the ground, 4) using specialized boom and nozzle designs, and 5) thickening the spray mixture by addition of various foaming agents, thickening polymers, or invert emulsion carriers.

Specific direction on drift control measures, calibration, and characterization of aircraft is contained in handbooks such as the Siskiyou National Forest Aerial Applicators Handbook, 4/82; the Gold Beach Ranger District Aerial Implementation Plan, Spring 1983; and the Region 5 Handbook on Aerial Application of Herbicides, 6/83. These are on file in the Regional Office in Portland, Oregon. Current technology in aircraft and guidance systems, aerial delivery systems, aerial spray models, aerial calibration, microsite weather, and quality control is provided to Forest Service personnel in training sessions such as the National Pesticide Application Training held in Marana, AZ, Oct. 1986.

19. Buffers are required along streams, open water, and wetlands. The following will be considered as minimum widths, and may need to be expanded depending on local conditions. The buffer width for lakes and wetlands is wider than streams because of the high water table surrounding these areas. Large quantities of herbicides can be flushed by a rise in the water table. There is also less opportunity for chemical dilution and mixing in lakes and wetlands than in flowing streams.

    For each project involving use of herbicides, buffers will be designed along all stream channels, lakes and wetlands to meet the following objectives. These objectives are based on the possible modes of chemical transport to surface waters (direct application, drift, overland flow, subsurface leaching, and mobilization in ephemeral stream channels), as well as protection of riparian vegetation.

    A. Prevent direct application to open water.

        i. Truck mounted spray rigs will have an on/off switch inside the vehicle which the driver can operate at stream crossings.

    B. Reduce drift into surface waters to meet project objectives. The acceptable amount of drift reaching surface waters will be

determined for each proposed project based on the value of the water resources and downstream uses. Operational considerations, including topography, existing vegetation, environmental conditions, and mode of application will be incorporated into the project buffer strips. Buffer strips will be marked prior to spraying to be visible to applicators in aircraft, trucks, or on-the-ground, whichever is applicable. As a minimum, the following unsprayed widths will be maintained and may need to be expanded depending on local conditions:

i. For aerial application, 200 feet horizontal distance around wetlands and lakes.

ii. For aerial application, 100 feet along all flowing streams (Class I-IV).

iii. For other than aerial application, 50 feet along all flowing waters. A distance less than 50 feet may be considered depending on site specific factors such as slope, soil, climate, and risk of contamination.

C. The following items will be considered in project-level analyses and may result in expansion of the buffer widths to meet project objectives:

i. The possibility of significant rainfall within the next 60 days; topography adjacent to surface water; soil infiltration capacity; amount of ground cover; flow obstructions that retard overland flow; and herbicide persistence and mobility will be considered. The value of the water resource for fisheries, municipal, domestic, industrial, and irrigation use will be considered.

D. Reduce the risk of subsurface leaching and mobilization due to a rising water table.

i. Considerations include: depth of water table; soil permeability; possibility of a rise in the water table; leaching within the 60 days following application; herbicide mobility and persistence; and the downstream water use.

E. Minimize chemical introduction to ephemeral streams.

i. Consider the time since the last rainfall; chance of significant rainfall in the 60 days following chemical application; soil moisture; land slope; downstream water use; and herbicide mobility and persistence.

F. Protect the riparian vegetation from the toxic effects of the applied herbicides.

   i. Consider the value of the riparian vegetation for stream channel stability; stream shading; source of large woody debris input for fish habitat; support for aquatic food chain; and value for terrestrial wildlife. Also consider the toxicity of the herbicide to riparian plant and animal species.

20. Aircraft operators shall shut off herbicide application during turns and over open water, residences, and sensitive sites.

21. Appropriate management of streamsides along dry Class IV streams will be determined during the project-level environmental assessment. Predicted rainfall, downstream uses and values, vegetative and soil conditions, and wildlife habitat will be evaluated when considering herbicide use in these areas.

22. When transporting more than 120 gallons of herbicide concentrate or 2,000 gallons of mix on forest roads within municipal, fish hatchery, or irrigation supply watersheds, a pilot vehicle will be used. Truck drivers shall be briefed on all haul route hazards, defensive driving, the project safety plan, and must be familiar with the Spill Incident Response Plan.

23. Both worker and public exposure monitoring is required for all herbicide application projects. Pertinent details will be documented, including herbicides used, land areas treated, dates and times of applications, people involved, and mitigation measures followed.

24. Monitoring must be planned as an integral part of the overall vegetation management project. Monitoring will be conducted as described in the Region 6 Water Quality Monitoring Guide for Pesticide Detection (R6-WS-040-1980). Monitoring of a spray operation will be conducted to determine if mitigation measures are 1) being observed, 2) effective in maintaining water quality, and 3) in compliance with state water quality standards and pesticide label requirements. The potential for contamination of aquifers used for municipal, fisheries, or irrigation use will be considered in the project level Environmental Assessment Report.

25. Herbicide use will be conducted in accordance with direction in Forest Service Manual 2150 (Pesticide-Use Management and Coordination). This defines the authority for Forest Service use of pesticides (the Federal Insecticide, Fungicide, and Rodenticide

Act). The objectives and responsibilities of the different administrative levels are documented. This directive includes the requirement for environmental documentation, safety planning, and training when pesticides are used.

26. Forest Service Handbook 2109.11 (Pesticide Project Handbook) will be used to direct project planning. This establishes procedures to guide managers in planning, organizing, conducting and reporting pesticide use projects. Also included is the requirement for a post-treatment evaluation report and the pesticide-use report.

27. Standards and guidelines in Forest Service Handbook 2109.12 (Pesticide Storage, Transportation, Spills, and Disposal Handbook) will be met. This defines standards for storage facilities, posting and handling, accountability, and transportation. It covers spill prevention, planning, cleanup, and container disposal requirements.

28. Forest Service Handbook 2109.13 (Pesticide Project Personnel Handbook) will be used to define responsibilities and personnel needs, training, and experience needed for large scale aerial or ground application projects.

29. Project safety will be guided by Forest Service Handbook 6709.11 (Health and Safety Code Handbook, Chapter 9). This directive establishes the basic safety rules, as well as storage transportation, and disposal safety aspects. References and publications to aid in worker safety training are also identified.

30. Individual National Forests will provide guidance for large and complex projects, as appropriate. This will be in the form of Forest Application Handbooks, Project Safety Plans, Environmental Monitoring Plans, Public Contact Plans, or Law Enforcement Plans. This is where specific requirements for equipment standards, training and quality control, and safety needs are identified for project implementation. Special measures such as spray drift control technology, water monitoring standards, calibration of equipment, and on-site weather limitations are prescribed. These documents also define coordination needs with support organizations and facilities.

31. Pesticide Applicator Licensing and Training will be used as a quality control measure. The Pacific Northwest Region will continue to utilize the programs administered by the Departments of Agriculture in Washington and Oregon. Training and testing of applicators covers laws and safety, protection of the environment,

handling and disposal, pesticide formulations and application methods, calibration of devices, use of labels and data sheets, first aid, symptoms of pesticide exposure, etc.

32. Material Safety Data Sheets will be posted at storage facilities, in vehicles, and made available to workers. These provide physical and chemical data, fire or reactivity data, specific health hazard information, spill or leak procedures, instructions for worker hygiene, and special precautions.

33. Care will be taken to avoid skin contact with diesel oil and kerosene. If contact does occur, affected skin areas should be promptly washed with soap and water, and soaked clothing will be changed.

Herbicide Use Under Alternative H

All vegetation management tools (manual, mechanical, burning, biological, herbicides, and no-action) are appropriate responses under Alternative H. Each National Forest, however, will actively look for opportunities to reduce their past reliance on herbicides.

Herbicides will be employed only when necessary to meet management objectives. This means that other methods would be ineffective (will not meet prescription objectives) or would increase project cost unreasonably.

Site-specific environmental, biological, sociologic, and economic factors will be considered. The following factors are basic elements in the process of site analysis, selection of strategy, and design of any vegetation management project:

- management objectives, required mitigation measures, and anticipated resource outputs;
- the potential risk of adverse human health effects, for both workers and the public;
- the risk of unacceptable environmental damage;
- feasibility of the project (including logistics considerations, as well as the availability of money, people, time, and equipment); and
- the potential to develop preventive strategies by incorporating modifications to "pest" habitat, or through complementing natural ecosystem processes.

Implementation

During implementation of the vegetation management program, each National Forest will provide guidance to project planners and those writing management prescriptions.

Figure II-8

Activity and Implications by Alternative

Alternative	A	B	C
Acres managed annually for competing and unwanted vegetation:			
Total	552,100	553,000	86,600
Using herbicides	0	59,900	0
Using mechanical methods	184,600	167,200	44,900
Using manual methods	99,000	77,800	17,700
Using biological methods	14,800	4,300	3,800
Using prescribed fire	217,800	202,000	0
Receiving no treatment	24,400	19,900	15,600
Other	11,500	14,100	4,800
Anticipated Number of Worker Accidents Per Year (from combined use of manual methods and prescribed burning, by alternative):			
Minor injuries	1,250	1,053	189
Major injuries	30	29	3
Emissions from Prescribed Fires (Change from 1983-85):			
West-side	36% less	33% less	no burning
East-side	33% less	35% less	for veg. management
Long-Term Sustained Yield Capacity: (Change from Alt. B in million board feet)	95 to 125 less	0	1,000-2,000 less
Present Net Value: (Change from Alt. B in million dollars)	468 less	0	3,877 lower
Change in Jobs: (Change from Alt. B)	1,100 fewer	0	21,700 fewer

Unit definitions, data sources, and assumptions discussed in preceding text.

D	E	F	G	H
380,500	548,600	566,400	579,600	543,248
26,800	47,900	64,100	76,600	51,492
111,600	166,900	201,000	155,600	162,018
57,800	95,100	80,100	85,700	79,658
18,700	5,900	8,300	6,900	7,445
125,800	194,000	175,800	202,000	202,017
23,800	24,100	36,100	21,500	31,770
16,000	14,700	11,000	18,300	8,848
741	1,152	1,004	1,126	1,017
19	27	25	30	26
63% less	46% less	63% less	35% less	63% less
60% less	37% less	53% less	31% less	60% less
55-85 less	35-65 less	95-125 less	95-125 more	0
246 less	132 lower	322 lower	24 higher	4 less
3,100 fewer	1,300 fewer	3,100 fewer	2,600 more	500 fewer

When treatment options are relatively equal (based on the factors considered), the non-chemical option will be selected.

The Forest Pest Management staff, along with other resource staff groups in the Regional Office, will assure that there is a consistent understanding of the intent of the herbicide use policy. They will also assure that the major factors considered in the analysis, method selection, and design process are similar on all Forests.

Monitoring

A monitoring process will be established to measure the shift over time in the relative use of herbicides, in comparison with other methods. It is anticipated that herbicide use, Region-wide, will range from 65 to 75 percent of historic levels (that is, compared to the five-year period from 1979 through 1983) when the direction is fully implemented.

Chapter III

Affected Environment

Chapter III

What Reviewers Said	Our Response
1. The whole noxious weeds section is not well developed, and not enough information is presented.	1. We rewrote the entire section on noxious weeds, adding detail and depth to the information presented in Chapter III and especially in Chapter IV. Information is also provided in Appendix G.
2. Not enough detail is displayed in the wildlife section.	2. We revised the material in the wildlife section and added many details.

Chapter III

Affected Environment

Introduction

This chapter describes the existing environment of the Pacific Northwest Region that would be affected by implementing the proposed EIS alternatives. It is a summary of the physical and biological setting of the Region, its social and economic characteristics, and factors affecting the Region's resources.

Location and Setting

The Pacific Northwest Region includes the states of Oregon and Washington, as well as portions of two counties in northern California and three counties in western Idaho. (See Figure III-1.) Approximately 500 miles long (north to south), and 380 miles wide (east to west), the Region has a total area of 106 million acres. The Forest Service administers 24.5 million acres, including 19 National Forests and one National Grassland, and assists in the protection and management of 20.5 million acres of other commercial forest lands through cooperative programs with private landowners and state and local governments.

Water, volcanic activity, and glacial events in the Region have created a great variety of landforms, ranging from coastal dunes and flat grasslands to rolling hills and steep, highly dissected hillsides.

The major geological feature in the Region is the Cascade Range, which parallels the Pacific coastline about 100 miles inland. Volcanic peaks over 10,000 feet in elevation regularly punctuate the length of the Cascades, but the main crest averages about 6,700 feet, a significant barrier to cyclonic marine storms. Their "rain shadow" makes the Eastside dry.

The Coastal Ranges comprise another major feature west of the Cascades. Parallel to the Cascades, they are much lower in elevation (about 3,000 feet). Forests west of the Cascade crest are wet, with even

Figure III–1
National Forests of the Pacific Northwest Region

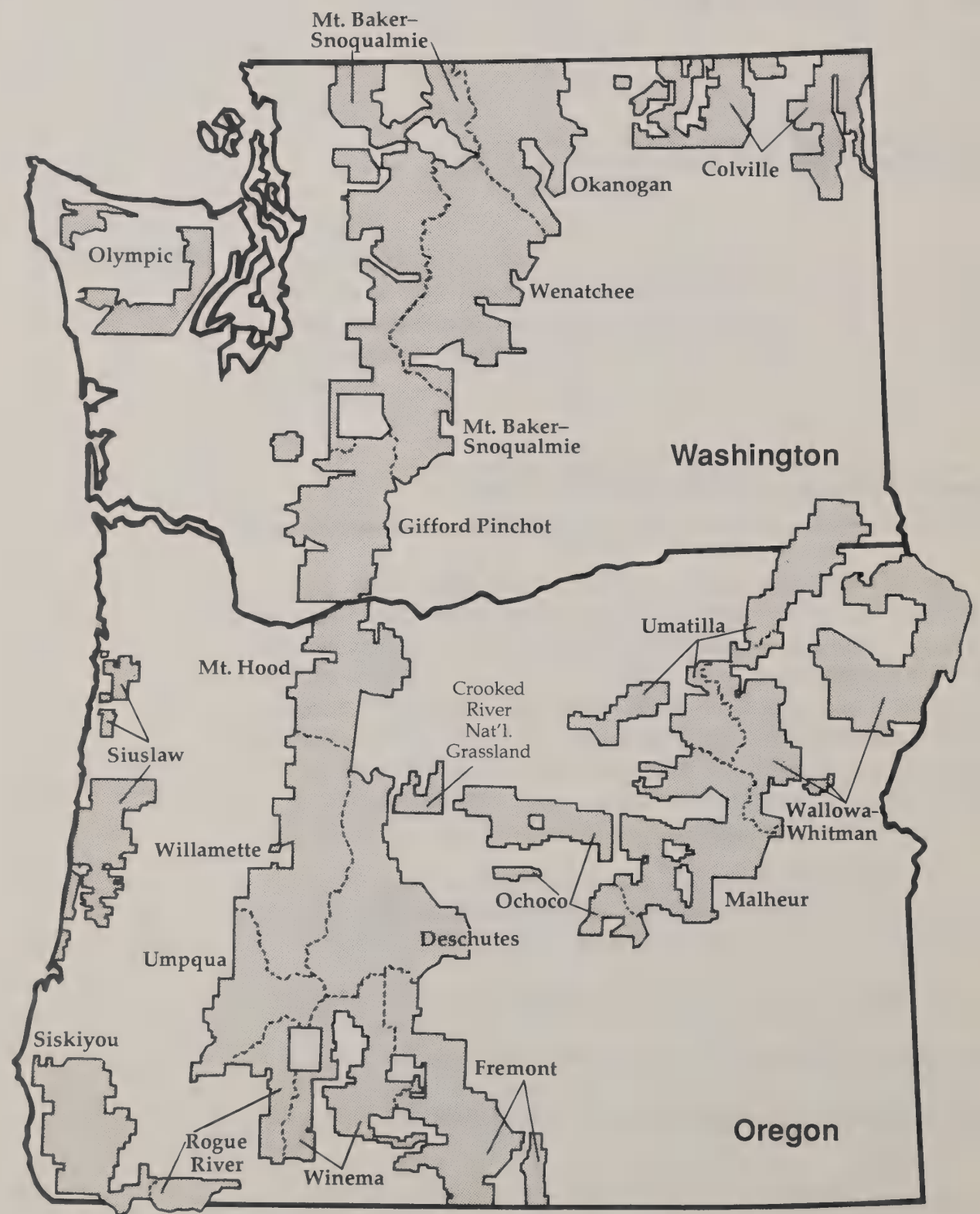


Figure III–2

Geographic Features of Oregon and Washington



temperatures characteristic of a marine-dominated climate.

The Coast Range and the Cascades break the Region into four areas that have similar topographic features, climate, and reaction to management activities (see Figure III-2, and Table III-1 below).

Table III-1

Geographic Subregions of the Forests



Coastal	Western Cascades	Transition	East-side
Olympic	Mt. Baker-Snoqualmie	Wenatchee	Okanogan
Siuslaw	Gifford Pinchot	Deschutes	Ochoco
Siskiyou	Willamette	Winema	Fremont
	Umpqua		Malheur
	Mt. Hood		Umatilla
	Rogue River		Wallowa-Whitman

Slopes in the Coastal Forests are generally steep but short, and heavily influenced by the marine climate. The East-side Forests are much less steep, and are in the rain shadow of the Cascade Range. The Transition Forests are a mixture of the two extremes.

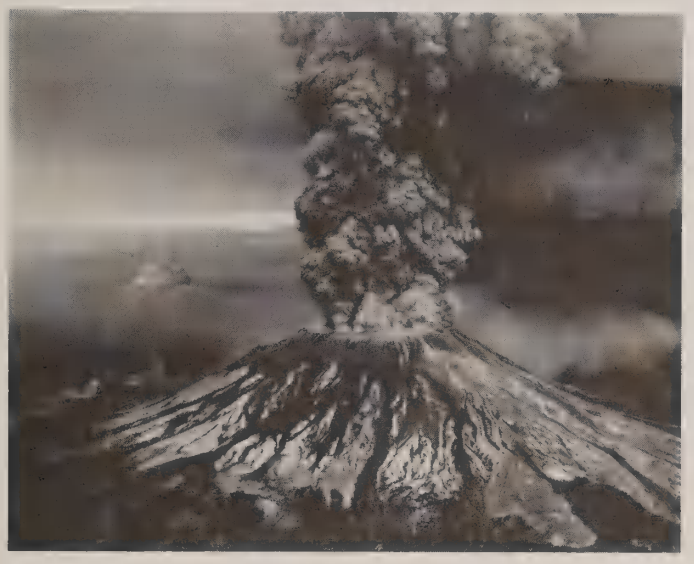
Geology

The geology of the Region is dominated by the Cascade and Columbia River vulcanism, and muddled by local intrusions of igneous rocks, faulting, uplift, and metamorphism. The composition, age, and structural integrity of these rocks often determines the course of management.

Sediments of the Coastal Forests are generally porous, erode easily, and are prone to mass movement. The Klamath Geological Province (Siskiyou National Forest) and the Olympic area, however, are much more complex. Geologists are commonly used to interpret local geology for site-specific projects.

The Cascade, Transitional, and East-side Forests are commonly basalt or andesite (extruded fine-grained lava), but a significant portion of the East-side has been covered by ash and pumice during

recent volcanic eruptions. The basalts are relatively stable and fertile, but the ash and pumice are infertile and erodible.



The Pacific Northwest has a variety of landforms, including active volcanoes such as Mount St. Helens (May 18, 1980 photo).

The Blue Mountains and Wenatchee Mountains are distinctly more complex than the rest of the East-side Forests. The old limestones, mudstones, and sandstones of the Blue Mountains can be locally unstable and difficult to manage.

The Wenatchee Mountains seem to have every known rock type. Moreover, glaciation has mixed and redeposited materials, creating new landforms. The effects of vegetation management are difficult to predict. Averages are almost meaningless; site-specific analysis is essential.

Climate

A parade of winter storms and the summer Pacific high pressure area are the dominant Regional climatic features. The winters are notably wet (typically 80 percent of the total annual precipitation falls in winter), and the dry summers are inconsistently interrupted by localized thunderstorms, particularly in the Transition and East-side Forests.

Coastal Forests High rainfall (over 150 inches at the coastal crest), and summer fog keep the Coastal Forests wet most of the year. Temperatures are moderate. Freezing temperatures and snow are experienced only during midwinter.

Cascade Forests Cascade Forests receive from 100 inches of annual precipitation on the Rogue River and Umpqua National Forests to over 150 inches on the Gifford Pinchot and Mt. Baker-Snoqualmie National Forests at the north end of the Region. Snow packs last well into summer, feeding many permanent streams. Late spring frost is common.

Transition Forests The rain shadow produced by the Cascades reduces the annual rainfall significantly in the Transition Forests. Because the moderating marine influence wanes at the Cascade Crest, average annual temperatures can be 10 degrees Fahrenheit lower than Cascade sites.

East-side Precipitation on the East-side Forests is less than 20 inches annually in some areas. However, most of the Forests are located on mountain ranges or uplands (the Wallowa Mountains, the Blue Mountains, and the Okanogan Highlands), and precipitation increases with elevation, as does the potential for summer lightning storms. Summers are hot and dry, and frost can occur any time of year.

Soils

Soils take on many of the characteristics of the rock from which they are formed. For example, serpentinites in the Wallowa-Whitman, Wenatchee, and Siskiyou National Forests produce nutritionally unbalanced, unproductive, and unstable soils. The young ash and pumice deposits from the eruptions of Crater Lake and Newberry Crater (and more recently from Mount St. Helens) offer more nutritional balance than serpentinites, but are relatively sterile and erodible.

Soil texture and surface conditions are key concerns because they relate to soil porosity, infiltration, and percolation rates. These variables relate to the fate of chemicals in the soil system and the productivity of the site. However, they must be analyzed on a site-specific basis. Few characteristics are common throughout the Region. Granitic materials and sandstones, however, are often very coarse and porous.

Unstable or potentially unstable soils are extensive on all Coastal Forests and on the Wenatchee and Malheur National Forests (East-side Forests). Instability is often associated with faults and weakly consoli-

dated bedded (layered) sediments, particularly when the bed planes are tilted. Deeply rooted vegetative cover is often the key to maintaining stability and reducing erosion.

Soil depth, texture, and productivity vary throughout the Region. Some of the deepest, most productive forest soils are found in the lower and gentler slopes of the Cascade and Coastal Forests, below the 2,000-foot elevation. Douglas-fir and western hemlock growing on these soils are capable of producing over 200 cubic feet (1,100 board feet) per acre per year.

At mid to high elevations, the soils are frequently moderately deep, stony, and occur on steep to very steep slopes. These soils produce from 50 to 150 cubic feet (280 to 840 board feet) per acre per year of wood growth from Douglas-fir, hemlock, and true firs.

In parts of the Transition and East-side Forests, there are many acres of soils derived from coarse-textured volcanic pumice. These areas are characterized by low to moderate productivity for ponderosa pine, lodgepole pine, and true firs at the highest elevations. Wood growth on these sites ranges from 10 to 50 cubic feet per acre per year.

Soils developed from volcanic ash are common in the Blue Mountains of northeast Oregon and in northeast Washington (East-side Forests). These soils usually are mixed with soils from glacial till (mixed, unsorted material left by glaciers) in northeast Washington, and with residual and colluvial soils from basalt in the Blue Mountains. These soils are moderately productive, have high water storage potential, and support inland Douglas-fir and associated species. The basalt-derived soils in the Blue Mountains usually range from medium to fine in texture, and are shallow to moderately deep. Ponderosa pine is the dominant tree vegetation. Wood growth on these soils ranges from 10 to 110 cubic feet per acre per year.

On ash-derived and loess-derived soils (which are more common), grand fir is the dominant climax tree species (Johnson and Simone 1987; Hall 1973).

As soils age, they accumulate organic debris (needles, leaves, limbs, dead animals, and, less often, tree trunks) which is gradually incorporated into the soil. This debris is an important factor affecting long- and short-term site productivity. Referred to as "duff," it protects the soil surface; provides food and habitat for small mammals and microorganisms; and slowly releases nutrients for plant growth. The status of this complex soil ecosystem is a major concern in all vegetation management activities.



Fires, both natural and human-caused, play a significant role in the evolution of Forest ecosystems within the Pacific Northwest Region.

Fire

Fire, both natural and human-caused, plays a significant role in the evolution of Pacific Northwest ecosystems. Fires influence the physical and biological forest environment through effects on both individual species and communities. The prevalence of many plant species with special adaptions to fire provides convincing evidence that fire is an integral part of many Pacific Northwest ecosystems. Typical fire adaptations include cone serotiny (cones that require heat to open and release seeds), the ability of species to sprout after tops are killed, and the heat-induced germination of seeds having the ability to remain viable in the soil for long periods.

Wildfire history varies throughout the Pacific Northwest depending upon an area's vegetation (fuel), topography, climate, and the coincidence of ignitions with the weather and fuel moisture conditions that allow a fire to burn. Wildfire regimes are defined by wildfire frequency, severity, and size. Seven fire regimes are recognized:

0—no natural fires

1—infrequent, light surface fires

2—frequent, light surface fires

3—infrequent, severe surface fires

4—short return-interval crown fires

5—long return-interval crown fires

6—very long return-interval crown fires

Historical Trends

Regime number 6—very long return-interval crown fires—was the presettlement fire regime of the Coastal and Cascade forests. Regimes 4 and 5 were characteristic of the Transition Forests and the interior mixed conifer stands of the East-side Forests. Regime 2—frequent, light surface fires—were characteristic of East-side ponderosa pine stands.

Lightning-caused wildfires are common principally in the Transition and East- side Forests. However, most large wildfires are human-caused. In the Coastal and Cascade Forests, heavy fuel loads, drought, warm, dry east winds, and human activity conspired to produce wildfires of extreme severity. The earliest of the great human-caused

wildfires in Oregon burned 500,000 acres between the Siuslaw and Siletz Rivers in the 1840s (Pyne,1982). In 1902, the Pacific Northwest experienced a rash of disastrous wildfires that ranks among the "top ten" of the most destructive wildfire episodes in United States history (Brown and Davis,1973; Pyne,1982).

Deliberate use of fire declined early in the 20th century as a result of a growing interest in conservation and a desire to reduce smoke. Catastrophic wildfires in the late 19th and early 20th centuries led to fire being regarded as a destroyer that should be prevented at all costs.

Modern forest fire protection began in the wake of these fires. However, in an attempt to eliminate destructive wildfires, the benefits derived from periodic burning of grasslands and forests (from frequent, light surface fires) and shrub lands (from infrequent, severe surface fires) were given up.

The era of fire exclusion has had a considerable impact on some fire-dependent Transitional and East-side Forest ecosystems. Periodic fires are essential to the functioning of these ecosystems. As a result of fire exclusion, successional patterns have been altered; nutrient cycling has been delayed; and vegetative debris has increased to unnatural, perhaps dangerous levels (Wilson and Dell,1971). In such instances, fire exclusion can be considered more of a disturbance than fire itself.

Current Conditions

The goals of fire management in the Forest Service in the Pacific Northwest Region are to reduce wildfire damage and to improve the natural resources with prescribed fire. Fire management is subdivided into two functionally distinct areas: wildfire protection and fire use. Wildfire protection consists of fire prevention, detection, and suppression. Fire use consists of prescribed burning to reduce wildfire hazard and to affect vegetation development.

Wildfire Protection

The current Regional wildfire policy emphasizes total suppression of all wildfires in a timely, cost-efficient, and safe manner. Suppression strategies are based on objectives designed to minimize both suppression cost and resource damage. Strategies range from immediate control (minimizing acres burned) to more indirect control through containment and confinement (minimizing cost).

During the 15 year period from 1972 through 1986, 24,494 fires burned 257,000 acres (1 percent of the Region's National Forests). Fires caused by lightning accounted for 43 percent of the fires and 32 percent of the acres burned. Human-caused fires accounted for 57 percent of the fires and 68 percent of the acres burned.

In 1986, more than 100,000 acres were burned in northeast Oregon; similar losses occurred in 1987 in southern Oregon.

Wilderness fire policy has changed considerably since the mid 1970s. Recognition of the role of natural fire in creating the conditions for which some wildernesses were established now prompts managers to take a moderate suppression position. Specifics of wilderness fire programs are included in individual Forest Plans.

Fire Use

Prescribed burning has been a common method for disposing of logging slash since the early 1900s. Recognizing the ecological benefits of fire, the modern-day land manager is using prescribed fire to improve wildlife habitat, restore and maintain rangelands, create visually pleasing vegetation patterns, and arrest succession to preserve seral plant communities.

The effects of prescribed fire can differ markedly from the effects of wildfire. In cases where a prescribed fire would benefit a partially cut stand, a wildfire could be very destructive. The prescribed fire would reduce the amount of logging slash; possibly expose some mineral soil to seed produced by the residual trees; and stimulate the growth of selected species for wildlife browse. A prescribed fire can also be planned to minimize impacts on air quality.

A wildfire, on the other hand, might kill all or part of the residual trees and remove most or all of the protective litter and duff layers, leaving the soil exposed to the erosive forces of wind and water. Reforestation of the damaged site could take many years.

Fuels are treated in an area to reduce the severity of any wildfire that may burn in that area. Fuels are either generated by human activity or occur naturally. "Activity fuels" result from logging, forest stand thinning, and road construction. Natural fuels result from processes such as windthrow or insect and disease mortality.

Besides burning, fuels are treated using mechanical methods, including crushing, machine piling (PUM), and yarding of unmerchantable material to the landing site (YUM). Manual methods, including hand piling, slashing, and scattering are also used. Promoting better utilization of residues (for example, as firewood, fence posts, and to generate steam and electricity) is also useful.

In 1986, 204,792 acres were prescribed burned. Of these, 45 percent of the acres were broadcast or underburned; 55 percent involved burning of piled materials. Treating logging slash accounted for 78 percent of the acres burned. The remaining 22 percent included acres

burned to improve wildlife habitat and range, and to reduce natural fuels.



Controlled burning has been a common method for disposing of logging slash since the early 1940's. Such burning will be less common in future years, due to better utilization of slash and an increased emphasis on maintaining high air quality.

Forest Service policy now allows prescribed burning in designated wildernesses with the approval of the Regional Forester. However, to date, no prescribed burning using "planned" ignitions has been done in the Region's wildernesses.

Future Trends

Burning of activity-generated fuels will be less common in the future. The decrease will be due to better utilization and the fact that less slash will be produced in the course of managing "cleaner" second-growth stands. Air quality considerations will force managers to use other methods where feasible.

Prescribed burning of natural fuels, principally on the East-side Forests, will expand. In keeping with the Region's policy to use prescribed fire where burning will benefit the ecosystem, it will be increasingly used to improve range and wildlife habitat, encourage fire-dependent plant species, and preserve wilderness ecosystems.

Cooperating Agencies

Cooperating agencies include the Bureau of Land Management, the Washington Department of Natural Resources, and the Oregon State Department of Forestry.

Air

Air is an integral part of the environment. Its character directly affects plant, animal, and human habitat, and affects the many scenic and recreational oportunities available in the Pacific Northwest.



Air quality varies widely from one part of the Pacific Northwest Region to another due to differences in population levels, industrial activity, topography, and meteorology. The Three Sisters Wilderness Area, shown here, is designated a Federal Class I area, to be protected from any but the smallest degradation of air quality.

The clarity and cleanliness of the air varies seasonally from one part of the Pacific Northwest to another due to differences in population distribution, industrial and agricultural activity, topography, and meteorology. More than 250,000 acres of grass fields are burned in the Willamette and Madras Valleys beginning in the middle of July. Locally (in both valleys) there are major problems with smoke from wood burned for space heating during the fall and winter.

Historical Trends

Smoke has been a matter of more than casual note in the Pacific Northwest for many, many years. Captain Vancouver commented about the smoke along the Columbia as did Lewis and Clark. Grasslands of the Willamette and Tualatin valleys were burned annually to improve the harvest of wild wheat. Early European settlers recognized the value of fire for thinning forests, reducing wildfire hazard, improving travel, and stimulating the growth of desirable plant species. Wildfires were common, particularly in the eastern regions

Newspapers in the late 1800s contained comments about "the immense volumes of smoke created by vast fires"; smoke was blamed for a variety of "seasonal distempers and diseases". Prior to the advent of industrial-scale logging, the chief argument for wildfire control was protection of the populace from smoke (Pyne, 1982).

Fire hazard abatement laws passed by both state legislatures before 1920 effectively institutionalized burning as the method for reducing and disposing of logging slash (Agee, 1988). Beginning in the 1930s, most slash burning was done in the fall. Thousands of tons of logging debris were burned during a very short period; smoke pollution episodes were not uncommon west of the Cascades. Temperature inversions and light winds, common at that time of year, caused the slash fire smoke to accumulate in the Puget Trough and the Willamette and Rogue Valleys.

Smoke particulates are solid matter or liquid droplets, other than water (Prescribed Fire and Fire Effects Working Team,1985). Because wood smoke particulates are so small (90 percent are smaller than 1/10,000th of an inch or 2.5 microns in diameter), it takes only a small amount to seriously affect visibility. Because their fall velocity is so low (four inches per hour), smoke particulates stay aloft for days, traveling great distances and affecting the visibility over wide areas. Chemically, smoke particulates provide sorption surfaces for polluting gases. Sorption is the chemical bonding of a substance to another substance.

Significantly, this fine particulate matter has the potential to aggravate respiratory conditions in susceptible individuals (Sandberg et al.,1979). Human health effects are presented in Chapter IV.

Smoke management programs (SMP), inaugurated in 1968 (Oregon) and 1969 (Washington) in the western sections of two the states, produced immediate improvements, but concentrated burning in the fall continued to cause problems. Beginning in the 1970s and continuing to the present, the move is away from fall burning and toward more spring and summer burning. Many changes have been made to those programs since the late 1970s in response to public desires and new laws and regulations.

Laws and Regulations

Public and scientific concern for urban air quality in the 1960s led to the passage of the Clean Air Act of 1963 (PL 88-206) which was amended seven times; the last amendment was the Clean Air Act of 1977 (PL 95-95). In the 1977 Clean Air Act, Congress shifted its attention away from the urban environment to the rural environment in order to protect "...the aesthetic, cultural, and recreational values of rural America."

In Part C of the Act, Sections 160 through 169 (the "prevention of significant deterioration", or "PSD" provisions), Congress directed that all areas of the country be placed into one of three classifications:

Class I: areas where anything but the smallest degradation of air quality would be socially unacceptable;

Class II: areas where moderate degradation of air quality would be socially acceptable; and

Class III: areas where a considerable degradation of air quality would be socially acceptable.

The Nation's wildernesses such as the Alpine Lakes Wilderness Enchantment Area shown here, are preserved in their natural, pristine state.



All national parks larger than 6,000 acres and wildernesses larger than 5,000 acres, and certain other preserves existing on August 7, 1977 were designated Class I areas. The remainder of the country was designated Class II. Additions to wilderness and national parks after that date are Class II until and unless redesignated Class I by the states.

Twenty Class I areas are located in Oregon and Washington; sixteen are national forest wildernesses and four are national parks.

Table III-2

Class I Areas in Oregon and Washington, North to South

Oregon	Washington
Mt. Hood Wilderness	Mount Rainier National Park
Eagle Cap Wilderness	North Cascades National Park
Hells Canyon Wilderness	Olympic National Park
Mt. Jefferson Wilderness	Alpine Lakes Wilderness
Mt. Washington Wilderness	Glacier Peak Wilderness
Three Sisters Wilderness	Goat Rocks Wilderness
Strawberry Mountain Wilderness	Mount Adams Wilderness
Diamond Peak Wilderness	Pasayten Wilderness
Crater Lake National Park	
Kalmiopsis Wilderness	
Mountain Lake Wilderness	
Gearhart Mountain Wilderness	

Congress also directed all federal land managers to comply with all federal, state, and local air quality regulations and to protect the "air quality-related values" of Class I areas. An air quality-related value is a feature or property of an area that is affected in some way by air contaminants. The only air quality-related value specifically identified in the Clean Air Act is visibility.

Section 169A of the Act sets "...as a national goal, the prevention of any future and the remedying of any existing impairment of visibility in mandatory Class I Federal areas in which impairment results from man-made air pollution."

The Environmental Protection Agency has developed and promulgated National Ambient Air Quality Standards (NAAQS) for six air pollutants: carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, ozone, and particulate matter. The standards were established to protect public health and welfare.

The states are responsible for developing and implementing programs to assure that the National Air Quality Standards and any other standards (visibility) are met. A State Implementation Plan (SIP) consists of a state's programs to assure the timely clean up of excessively polluted areas. Clean areas are called "attainment" areas; excessively polluted areas are called "non-attainment" areas. An area may be an attainment area for several criteria pollutants, but classified as non-attainment for others. States may adopt standards more stringent than the National Air Quality Standards.

Currently, there are three non-attainment areas for total suspended particulates in Oregon: Portland, Eugene-Springfield, and Medford (Oregon Department of Environmental Quality,1985). In western Washington, Vancouver, Seattle, Tacoma, Renton, Kent, and Longview are non-attainment areas for particulate matter. In eastern Washington, Spokane and Clarkston are also non-attainment areas for particulate matter.

Washington and Oregon Smoke Management Plans are now part of the State Implementation Plans for both states. They detail the procedures and lines of authority for land management burning in the two states. In Oregon, the Oregon Department of Forestry is the responsible agency; in Washington, the Department of Ecology and Department of Natural Resources share the responsibility.

Numerous areas in the Region are classified "designated areas" in the Smoke Management Plans (Figure III—3). Designated areas are typically the larger population centers. A "smoke-sensitive area" is an area that would be negatively affected by smoke, but is not necessarily a designated area. All communities and the orchard areas of Okanogan, Chelan, Douglas, Kittitas, Benton, and Yakima counties in eastern Washington are designated as smoke-sensitive areas.

Current Conditions

Visibility in the Region is being monitored by the states to determine the extent and causes of visibility impairment in Class I areas. Visibility in Class I areas is frequently impaired by uniform haze during the summer and fall. Beck and Associates (1986) reports that perceptible human-caused impairment within the Mt. Hood and Central Cascade wildernesses and Crater Lake National Park occurs 17 percent, 33 percent, and 4 percent of the daylight hours, (respectively) during summer months.

During periods of visibility impairment, slash burning accounts for 28 percent of the fine particulate pollution (particles with diameters less than 2.0 microns) in the Mt. Hood Wilderness. In the Central Oregon Cascades wildernesses, slash burning accounts for about 30 percent of the fine particle pollution (Beck and Associates, 1986).

In 1985 and 1986, Washington and Oregon amended their State Implementation Plans to include programs to comply with the visibility protection requirements of the Clean Air Act. Both contain provisions to limit prescribed burning during the summer to protect the visibility in Class I areas and to reduce smoke from forestry burning. Prescribed burning is restricted in the Oregon Cascades during the high visitor and recreation use period of July 4 through Labor Day.

Figure III-3

Class 1 Areas of the Pacific Northwest



Legend

Washington

1 Olympic National Park
2 Mt. Rainier National Park
3 Goat Rocks Wilderness
4 Mt. Adams Wilderness
5 Alpine Lakes Wilderness
6 Glacier Peak Wilderness
7 North Cascades National Park
8 Pasayten Wilderness

Oregon

1 Mt. Hood Wilderness
2 Mt. Jefferson Wilderness
3 Mt. Washington Wilderness
4 Three Sisters Wilderness
5 Diamond Peak Wilderness
6 Crater Lake National Park
7 Kalmiopsis Wilderness
8 Mountain Lake Wilderness
9 Gearhart Mountain Wilderness
10 Strawberry Mountain Wilderness
11 Eagle Cap Wilderness
12 Hells Canyon Wilderness

Washington restricts burning on weekends and during "visibility important" days during that same period.

Washington's 1990 goal is to reduce particulates from prescribed burning in western Washington to 35 percent below the level experienced during 1976-1979. By the year 2000, Oregon plans to reduce prescribed fire smoke in western Oregon by 50 percent.

The amounts of slash burned on National Forest and other public lands west of the Cascades have decreased in recent years, primarily because of better utilization. Conversely, there has been an increase in prescribed burning on private lands. The net effect between 1976-79 and 1984 is a very slight decrease in acres burned in western Oregon, and a 12 percent increase in acres burned in western Washington (Sandberg, 1986). A lack of documentation precludes a precise evaluation of prescribed burning trends east of the Cascades, but there is no doubt that the number of acres that receive prescribed burning has increased dramatically.

Emissions from prescribed burning on Coastal and Cascade Forests are now 30 percent less in Oregon and 28 percent less in Washington than during the period 1976-1979 (Sandberg, 1986; Sandberg et al., 1985). This decrease has been achieved with state-of-the-art emission reduction techniques. These include burning when the moisture content of large, woody fuels is high; using rapid ignition techniques; and utilizing woody debris that would have been left on site to be burned just a few years ago.

During the 1976-1979 baseline period, biomass consumption averaged 60 tons per acre in western Oregon and 58 tons per acre burned in western Washington. In 1984, biomass consumption per acre had droped to 44 tons per acre in Oregon and 37 tons per acre in Washington (Sandberg,1986). Equivalent baseline information cannot be developed for the areas east of the Cascades.

Future Trends

The Environmental Protection Agency revised the National Air Quality Standards for particulate matter in May, 1987. The old standard for particulates was based on total mass (total suspended particulates, or "TSP"), though only particles smaller than 50 microns in diameter were included.

The revised standard is for inhalable and respirable particulates only. Inhalable particulates are deposited in the uper portion of the human respiratory system and are easily expelled by a healthy person. Respirable particulates can be drawn through the pulmonary tract and deposited deep within a person's lungs. They are less than 2.5 microns

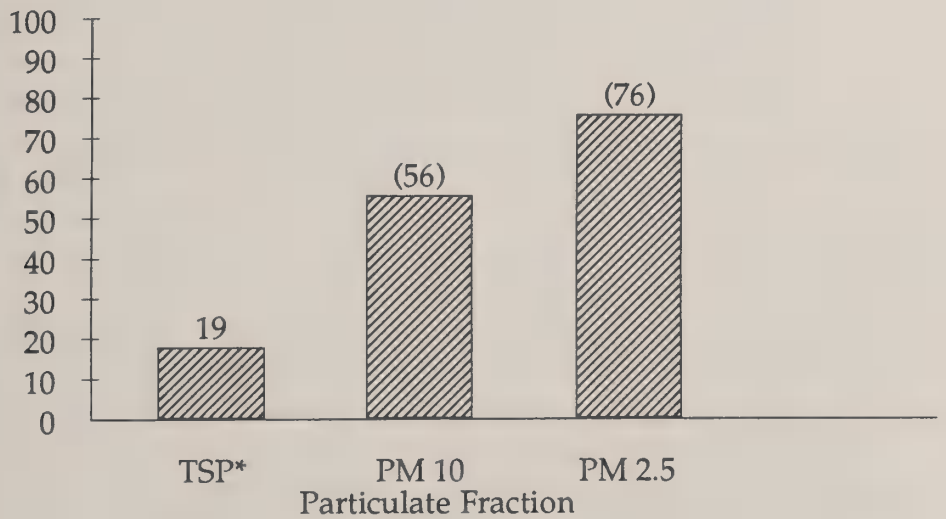
in diameter (PM-2.5).

The PM-10 standard is for both inhalable and respirable particulates, which are particulates 10 microns in diameter and smaller.

The PM-10 standard dramatically increases the importance of prescribed burning particulates to the air quality regulators. In Oregon, prescribed burning produces 19 percent of all particulate matter, 56 percent of the PM-10 emissions, and 76 percent of the PM-2.5 (Figure III-4, Haddow,1985). The PM-10 regulations require frequent monitoring in urban areas and in rural areas, some of which are certain to be close to the National Forests. This is a development that will certainly affect prescribed burning on the National Forests.

Figure III–4

Oregon
Proportion of Particulate From Forestry Burning
(Annual Basis)



* TSP — Total Suspended Particulates
PM 10 — Diameter ≤ 10 microns
PM 2.5 — Diameter ≤ 2.5 microns

The Environmental Protection Agency (EPA) is expected to promulgate a PM-2.5 standard in the next couple of years which will further increase the significance of prescribed burning smoke. The EPA regulators are starting to focus on the health and welfare of rural residents and visitors, and on the regional haze problem, all of which are significantly affected by smoke from prescribed burning. That is why we have chosen in this EIS to present PM-2.5 particulate emission information for the vegetation management alternatives in lieu of information on PM-10 and TSP particulate emissions.

With more attention being given to the health and welfare of rural residents and visitors; demands for improved visibility in Class I areas; and a growing interest in extending Class I status to recent additions to the Oregon and Washington wilderness systems, Pacific Northwest air quality will unquestionably benefit.

Cooperating Agencies

Agencies with responsibilities in air quality management include the Oregon Department of Forestry, the Oregon Department of Environmental Quality, the Washington Department of Ecology, and the Washington Department of Natural Resources.

Water

Current Conditions

The National Forests occupy 23 percent of the land in the Pacific Northwest, yet 44 percent of the Region's water supply originates on National Forest land. There are 112,000 miles of streams and approximately 216,000 surface acres of lakes and reservoirs which contain 75 million acre-feet of water. There are thousands of acres of wetlands and floodplains which provide unusually diverse habitat, particularly where the riparian and terrestrial ecosystems meet. The dynamic nature of this interface (changing of water levels and freezing and thawing) allows an unusually high number of species to survive.

About six million acres (approximately one quarter of National Forest lands) are used as domestic watersheds. About 800,000 acres are managed according to formal agreements with fifteen municipalities. Many of the agreements list specific restrictions. For example, the Cities of Ashland, Medford, Portland, Seattle and The Dalles prohibit or severely restrict the use of herbicides. There are approximately 60 watersheds managed for specific uses (such as ski areas) for which there is no formal agreement. Other uses of water originating in National Forests include irrigation, navigation, transportation, hydroelectric generation, livestock watering, and fish production and passage.

Water Quality

The quality and quantity of water produced by the National Forests depends on the management of vegetation and soils in each watershed. Managing streamside vegetation, roadside vegetation (particularly during and shortly after road construction), and vegetation in timber harvest units is key to maintaining water quality. Temperature, bacteria, and sediment commonly affect water quality. Water quality in National Forest streams is generally excellent. For example, water from the Bull Run watershed that supplies the City of Portland requires little treatment.

Federal agencies with responsibilities involving water resources include the Environmental Protection Agency, Army Corps of Engineers, United States Geological Survey, and the Soil Conservation Service.

Washington State agencies include the Washington Department of Game, Washington Department of Ecology, Washington Department of Fisheries, and Washington Department of Natural Resources.

Oregon State agencies include the Oregon Department of Environmental Quality, Oregon Department of Forestry, Oregon Water Resource Department, Oregon Department of Lands, Oregon State Health Division, and Oregon Department of Fish and Wildlife.

The North Coast Regional Water Quality Control Board (California) and the California Department of Fish and Game are also involved with management of water resources in the Region.

The management of vegetation and soils in each watershed plays a key role in determining the quality and quantity of water produced by the National Forests.



Vegetation

Background

Vegetation is often described by layers. The tree overstory is usually the most dominant vegetative feature, followed by the tree understory, shrubs, herbs, grasses, nonvascular plants (such as moss, lichens, and fungi) and small plants that live in the top layers of the soil.



Forest vegetation is often described in layers. The tree overstory is usually dominant, followed by the tree understory, shrubs, herbs, grasses, and nonvascular plants (such as moss, lichens, and fungi) and small plants that live in the top layers of the soil.

All layers are important to a fully functional ecosystem, but traditionally, vegetative provinces are named after the most visible layer. In the Pacific Northwest, Douglas-fir often visibly dominates the overstory, but is commonly replaced by shade tolerant, trees in the understory. These shade tolerant, "climax" trees are indicative of the long-term climate and the site's productive potential. Most ecological vegetation classification systems are based on such climax vegetation.

Shrubby vegetation is often the "target" (the specific species causing unacceptable damage) of control activities, but all other layers are also of concern. Trees, particularly noncommercial hardwoods—and western juniper, where grass is the favored species—can also be targets. Grasses can also be targets, particularly on dry sites where they compete with tree seedlings for water. The majority of noxious weeds are herbs, many from the sunflower family, a highly adaptive group. See the section on noxious weeds.)

Nontarget species (associated vegetation) are also of concern. Each species adds to the diversity of the ecosystem. Diversity provides structure and composition for animal habitat, resistance against epidemics, and resilience after disturbances. Each species plays a unique role in the ecosystem and contributes to overall site productivity. The

objective is to maintain the diversity in all layers. Thus, the objective of vegetation management has always been control rather than elimination, except where noxious weeds are involved.

Threatened, sensitive, and endangered species are of special concern. (See the section on Threatened, Sensitive, and Endangered Plant Species.)

Endangered species are Federally recognized. The Regional Forester has emphasized the need to prevent damage to any populations of endangered species. The objective is to actively manage to maintain or enhance existing populations. More information can be found in Forest Service Manual sections 2605 and 2670.5.

The following section briefly describes common vegetation in the four subregions (Coastal, Cascades, Transition, and East-side) described in the beginning of this chapter.

Coastal Vegetation

Douglas-fir, western redcedar, several true firs, western hemlock, and Sitka spruce characterize the Coastal subregion, except for the Siskiyou National Forest, where tanoak is common and dominant. Salmonberry, salal, rhododendron, vine maple, and evergreen huckleberry commonly dominate the shrub layer. Swordfern, and in places, brackenfern are the characteristic herbs.

Target Species. All of the shrubs mentioned above can be targeted for control. Salmonberry and vine maple are the most important competitors. However, tanoak, alder, and thimbleberry are serious problems on specific sites. Tansey, gorse, and the thistles are also targets for control.

Associated Vegetation. Hemstrom and Logan (1986) list 25 shrubs and 48 herbs and grasses in their Plant Association and Management Guide for the Siuslaw National Forest. Little is known about the competitive ability of many of these species. Information concerning their ecological role in maintaining long-term productivity is also lacking. Careful monitoring and research is needed.

The Siskiyou Mountains (in the southern part of the coastal area) have an unusually high number of sensitive species (112) that must be considered when planning and executing vegetation management projects. Major commercial species in the Cascade Range include Douglas-fir, true firs, and other conifers.

Cascade Vegetation

Western hemlock is the dominant climax species on the western slopes of the Cascades. It is replaced gradually by Pacific silver fir at the higher elevations, and ultimately, by mountain hemlock near timberline. A subalpine zone is also commonly found in this subregion. Many of the Coastal shrubs, such as rhododendron, vine maple, and salal are also common on the west slopes of the Cascades. Dwarf Oregongrape is extremely common throughout the Cascades. At the high elevations, gooseberry and several species of huckleberry are most common.

Target Species. Vine maple, ceanothus, and Pacific rhododendron are often considered for control. On some sites they can be as competitive as their Coastal counterparts. Except for a few sedges, competition at higher elevations seems to be less of a problem. Thin-leaved and Alaska huckleberry are uncommon as target species. Tansey, thistle, and skeletonweed are common noxious weeds.

Associated Vegetation. The Cascades are rich with shrub, herb, grass, and nonvascular species. The Plant Association and Management Guide for the Western Hemlock Zone (Topic, et al. 1986) and the Preliminary Plant Association and Management Guide (Hemstrom et al., 1985) for the Willamette National Forest present a detailed description of the vegetation in the Cascade area.

East-Side Vegetation

The East-side varies from forest to grassland. Douglas-fir, white fir, ponderosa pine, subalpine fir, lodgepole pine, grand fir, mountain hemlock, and juniper forests are found on the mountainous uplands. They grade into shrub-dominated systems where big sagebrush and bitterbrush are common. Bluebunch wheatgrass is dominant on many of the grasslands. See the section on Rangelands in Chapter IV and Appendix F for more information.

Target Species. Western juniper is often a major target species. It reduces grass and forage, decreasing the amount of utilizable range. Ceanothus and manzanita can also be quite competitive, but generally there has been less use of vegetation management on the East-side than in the Cascades or Coastal areas.

Noxious weeds are a serious threat to range production. There are a significant number of cattle poisoned each year (see the sections on noxious weeds). Many of these weeds are in the sunflower family, a group known for its ability to aggressively invade disturbed or slightly disturbed ground.

Noxious weeds that invade pastures or range are susceptible to selective herbicides that have little chance of damaging nontarget species.

Associated Vegetation. The Blue Mountains and the Wenatchee Mountains have a significant number of sensitive species to be considered when planning vegetation management activities.

Douglas-fir, ponderosa pine, subalpine fir, western larch, silver fir, and aspen are common on forested areas. Bitterbrush, huckleberry, ninebark, and Oregon boxwood are common shrubs. The herb layer is commonly composed of twinflower, heartleaf arnica, and yarrow. Pinegrass, Idaho fescue, bluebunch wheatgrass, cheatgrass, bluegrass, and a variety of sedges occur in the grass (and grass-like) layer. More information can be found in the Region's Ecology Series publications available at the Regional Office.

Transition Vegetation

The Transition Forests have a mix of forest, shrub, and grassland types typical of both sides of the Cascades. Mountain hemlock and lodgepole pine forests are characteristic of high elevations and pumice/ash parent materials. Grand fir and ponderosa pine are common at mid elevations on all types of soils. Western Larch and subalpine fir can also be locally important species.

Target Species. Snowbrush ceanothus is an important target species, particularly near the Cascades. It occurs on productive sites after site preparation and burning. Greenleaf manzanita can also be competitive. Both species invade after disturbances such as timber harvest, burning, and mechanical scarification.

Associated Vegetation. There is a rich mix of East-side and Cascade species in the Transition Forests. More information can be found the Region Six Ecology Series plant association and management guides available at the Regional Office.

Forests

Current Conditions

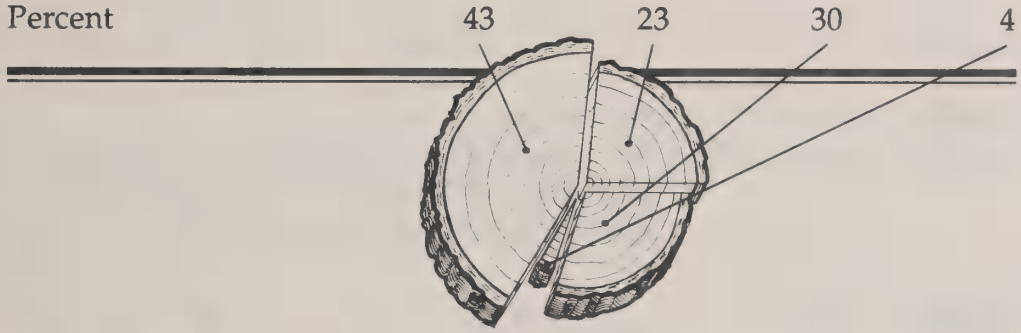
Much of the forested land within the National Forests of the Pacific Northwest Region is among the most productive in the world. Roughly 90 percent of the National Forest lands are forested. Of this, approximately 76 percent (18.5 million acres) has a productivity level equal to or exceeding 20 cubic feet per acre per year. Timberlands have traditionally divided into two broad subregions: the Coastal and

Table III–3

Timber Productivity on Available Commercial Forest Lands in the Pacific Northwest Region
(Cubic Feet per Acre per Year)

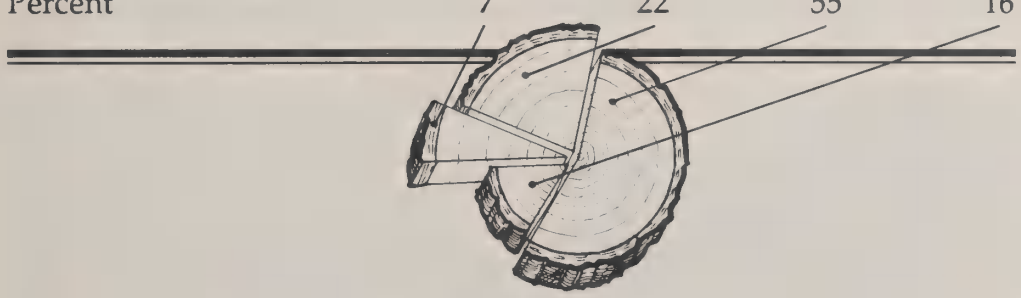
Coastal and Western Cascades Subregion Total Acres: 6,658,000

Productivity Class	120+	85-119	50-84	20-49
Thousand Acres	2,825	1,552	1,991	290
Percent	43	23	30	4



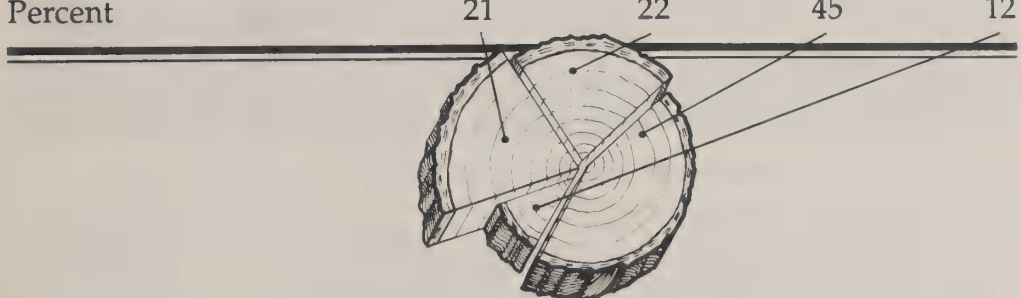
East-side and Transition Subregion Total Acres: 9,862,000

Productivity Class	120+	85-119	50-84	20-49
Thousand Acres	655	2,148	5,399	1,660
Percent	7	22	55	16



Total Region Total Acres: 16,520,000

Productivity Class	120+	85-119	50-84	20-49
Thousand Acres	3,480	3,700	7,390	1,950
Percent	21	22	45	12



Source: Regional Guide for the Pacific Northwest Region, 1984, USDA Forest Service.

Western Cascades subregion and the East-side and Transition subregion.

Inventory

The standing inventory of softwood sawtimber on commercial lands (capable of growing at least 20 cubic feet per acre per year) on Pacific Northwest Region Forests is of major significance when viewed from the National perspective.

Table III–4

Standing Softwood Volumes—Based on International 1/4-inch Scale—on Commercial Forest Lands of the Pacific Northwest Region

	Million Bd. Feet	Percent
Coastal and Western Cascades subregion	270,508	70
East-side and Transition subregion	115,944	30
Total	386,352	100

Source: Regional Guide for the Pacific Northwest Region, 1984, USDA Forest Service.

Demand

Demand for timber will vary with market and economic conditions, and is affected by short term decisions of other industrial and agency forest ownerships. As a general situation, however, there are purchasers for all volumes made available for harvest. Sale of timber from Forests will fluctuate somewhat on an annual basis according to National administrative and budget priorities. The 5-year average between 1975 to 1979 was 4.9 billion board feet sold on National Forests in Washington and Oregon.

Recent Trends

Recent trends of both harvest levels and acres available for regulated harvest (the systematic removal of products) are reflected in the proposed Forest Plans. While conditions vary from Forest to Forest, the trends are for somewhat reduced programmed harvest levels in comparison with recent historic levels. For example, it is estimated that annual timber harvest (Allowable Sale Quantity) will be in the range of 3.8 to 4.3 billion board feet following implementation of the 19 Forest land management plans currently in preparation.

Recent additions to the Wilderness System, allocations to protect sensitive resources, and analysis of costs have reduced the amount of

timberland in the "base"; programmed harvest levels reflect this. Harvest of timber from all Forests, however, will continue to be a valuable and significant activity.

In many situations, the removal of forest trees is the mechanism for achieving habitat, visual quality, forest protection, and other management objectives. In these cases, timber yields are the by-product of projects to enhance other resource values. They result from manipulation of forest density, species composition, horizontal or vertical distribution, and lesser vegetation.

Range Ecosystems

Current Situation

The Pacific Northwest Region contains 7,860,000 acres of range allotments. Of these, 6,300,000 acres are in Oregon and 1,560,000 acres are in Washington. More than 80 percent of National Forest grazing lands are forested, yet they also offer substantial opportunity for browse and forage. A discussion of range improvement activities is found in Appendix G.



The Pacific Northwest Region contains nearly 8 million acres of rangeland allotments.

The majority of the rangelands are in satisfactory condition in terms of site stability and vegetative composition. Range management opportunities exist throughout the Pacific Northwest Region. Eleven National Forests (partially or entirely east of the Cascade Mountains) produce a majority of the animal unit months of grazing by domestic

livestock (see Appendix F). These are the Forests most likely to practice vegetation management to improve range characteristics. On other Forests, livestock grazing occurs primarily on transitory range resulting from timber harvest.

The National Forests in the Pacific Northwest produce an estimated 1.5 billion pounds of useable forage on established allotments. In fiscal year 1986, 144,500 cattle and 54,900 sheep used approximately 727,100 animal unit months of forage on 785 National Forest range allotments.

Major Rangeland Types

The greatest range opportunities are generally associated with those National Forests found either in part or totally within the Transition and East-side subregion (see Appendix F).

The vegetation types that perennially provide a constant base of forage include:

1) forested lands with a dominant bunchgrass understory;

2) pure grasslands;

3) shrub/bunchgrass;

4) juniper/shrub/bunchgrass; and

5) meadowlands.

Another very important type is transitory rangeland associated with managed forested lands. More detailed descriptions of each of these major types are found in Appendix F.

Riparian Vegetation

Riparian vegetation includes any nonaquatic vegetation that directly influences the stream environment. The riparian zone is the area bordering streams, lakes, and wetlands. It is transitional between aquatic and upland zones.

Current Conditions

Riparian plant communities may be dominated by: 1) herbaceous species (mainly rushes, sedges, and grasses); 2) hardwood species (mostly alder, bigleaf maple, willows, Oregon ash, or black cottonwood); or 3) coniferous species (mostly western hemlock, Sitka spruce, or western redcedar).

There are approximately 775,000 acres of riparian areas within National Forest lands in the Pacific Northwest Region. Riparian areas constitute 1 to 6 percent of the suitable timberlands on East-side Forests, and 3 to 14 percent of the timberlands on West-side Forests.

Importance

While riparian areas occupy only a small part of the overall land base in the Region, they are a critical source of diversity (See Diversity, this chapter) within the forest ecosystem. They create distinct habitat zones within the drier surrounding areas.

Riparian vegetation provides a source of food, cover, shade, and woody debris for fish and wildlife. Vegetation growing along stream banks helps to stabilize the banks and create habitat for fish. The litter layer serves to filter sediment transported from upland areas by surface erosion. Riparian areas are also highly productive sites for timber and forage.

CFR 219.7 directs the Forest Service to protect riparian areas. No management activities are permitted within riparian areas that will cause detrimental changes in water quality, block water courses, or deposit sediment which will seriously and adversely affect water or fish. The Forest Service Manual (FSM 2526) provides further direction for protection of riparian areas.

Noxious Weeds

Background

While some plant species classified as noxious weeds (plants that have an adverse effect on humans or the environment) are native to the Northwest, most are introduced species from Europe or Asia. Weeds continue to be introduced and spread by contaminated seed, vehicles, livestock, and natural elements such as wind, water, and wildlife.

Noxious weeds have become established and are rapidly spreading on both public and private lands. As a result, crop yields on agricultural lands are being reduced, rangelands are being invaded, and wildlife habitat is being reduced. Economic losses from these infestations are substantial.

Noxious weeds include both herbaceous and brushy species that are able to adapt rapidly to a variety of environmental conditions. The rapid spread of these species is largely due to the fact that they were introduced without the natural complex of predators, competitors, and



The production of toxic chemicals, high rates of seed production, efficient seed dispersal, and rapid root growth and vegetative spread often give invading noxious weeds an advantage over desirable plant species. Canada thistle, illustrated here, is present in every county in Oregon and Washington.

diseases that provided a natural means of control in their native habitats.

Characteristics such as production of toxic chemicals (allelopathy), high rates of seed production, efficient seed dispersal, and strong abilities for rapid root growth and vegetative spread often give invading noxious weeds an advantage over native plant species.

Noxious weeds often act as pioneer species. They are adapted to colonizing the exposed mineral soil of the disturbed sites. Many activities (including timber harvest, grazing, prescribed burning, recreation, and road construction) provide opportunities for establishment and spread of these species.

Most poisonous plants of concern are native and increase in acreage due to many variables. In some cases, it is necessary to reduce poisonous plant densities to meet land management objectives. Poisonous plants are targeted for treatment in specific locations where there is substantial livestock loss or when human health hazards exist. Because the majority of poisonous plants are native and contribute to the species diversity and stability of the ecosystems in the Region, noxious weed control strategies differ from poisonous plant control strategies.

As noxious weeds invade and occupy a site, they do so at the expense of native or desirable non-native plants. In most cases, native plant species will provide higher quality forage. In some cases, the displaced native plants may be threatened, endangered, or sensitive species.

Forests can serve as seed sources, providing corridors for noxious weeds to move into surrounding agricultural lands. Severe economic losses to farmers and ranchers have been attributed to the establishment and spread of noxious weeds.

Current Conditions

The current distribution of noxious weeds in the Pacific Northwest Region varies by species. It depends in part on when the weeds were introduced, and how much suitable habitat is available for the establishment and spread of a given species.

For instance, Canada thistle is present in every county in Oregon and throughout most of Washington, while Dyers woad (which is spreading into Oregon from the south) still has a relatively limited distribution. Tansy ragwort is common west of the Cascade Mountains (and is being spread eastward by interstate movement of livestock and hay). Knapweed and leafy spurge are more common in eastern Oregon

and eastern Washington.

A complete list of noxious weeds by treatment class (including specific information about their distribution and spread by county) is available in the Final Environmental Impact Statement for the Northwest Area Noxious Weed Control Program (Appendices C-1, C-2, C-3, and Appendix D), published by the US Department of the Interior, BLM, in 1985. A partial listing of noxious weeds and biological control agents used against them can be found in Appendix G. Additional specific information is available in the noxious weed management plans of the individual Forests.

A discussion of the basis for, and the methods of, noxious weed control can be found in Appendix G. Project level analysis must be used to determine the most effective, cost efficient method for controlling weeds while minimizing the risks of adverse consequences.

Cooperation With Other Agencies

Noxious weeds do not respect jurisdictional boundaries or land ownership. Control efforts are effective when they are supported by the public and fully coordinated between federal, state, and local agencies and private land owners to treat infested lands regardless of ownership. Treatment programs cannot be effective if one segment of land is intensively treated while adjacent lands in other ownerships are not brought in on the program coordination.

The Oregon Department of Agriculture (ODA) has responsibility for noxious weed control within the state of Oregon. Control activities planned on National Forest lands are coordinated with, and often completed in cooperation with, the ODA.

Noxious weed control responsibilities lie with individual county weed control boards within Washington State. Cooperation with these weed control boards is essential for a successful program.

Diversity

Diversity has both spatial and temporal dimensions. Differences in productive potential from site to site are spatial; differences related to time, successional changes, for example, are temporal. Site-specific prescriptions or projects plans should consider the need for both types of diversity.

Temporal Diversity

Temporal diversity usually relates to change over time in species composition and structure following a disturbance.

Disturbances usually result from natural environmental extremes such as high wind, drought, flood, mass failure, or fire. Each of these agents has its own natural frequency—for example, 100-year floods, or the somewhat regular, almost predictable, occurrence of fire in Northwest ecosystems. Effects depend on the intensity and extent of the individual event. Severe fire, for example, can set back the ecosystem to early developmental stages, while less intense fires may only kill a few susceptible individuals.

Disturbances seemingly occur on a random basis. While this makes the natural ecosystem appear chaotic, the resulting variety of age classes (temporal diversity) support both early seral (an unstable early stage of development) and climax (the last stage of stand development) vegetation species. This contributes to the overall plant diversity essential to many species of wildlife.

Most areas in the Region have some variety in age classes (temporal diversity). The proportion of old-growth to young or recently disturbed stands depends partly on the periodicity of natural events.

Spatial Diversity

Spatial diversity is related to differences in site potential. It reflects the influence of the climate, and also the energy already stored at the site (in the soil, and in both living and dead vegetation).

The structural components, layers of vegetation, structure of the soil, and accumulated debris on the forest floor give each site a character that attracts animals and allows plants to find a niche to compete for resources. For a related overview, refer to the section in this chapter on Regional vegetation.

Current Conditions

A standard method of dealing with diversity is being developed. It will include elements of composition (plants and animals), age class, and habitat structure and their distribution across the landscape.

We can use vegetation management to help maintain diversity or reduce it, depending on the strategy used in application. Vegetation management activities are designed to take both structural diversity and species diversity over time and space into account. These activities can be patterned after the frequency, intensity, and extent of natural disturbances to maintain and possibly enhance the character of the ecosystem, but in most cases, vegetation management will not significantly affect diversity.

Diversity indices may be used for monitoring richness and eveness. Analyses will evaluate trends, and where possible, compare new information with baseline measurements.

Threatened, Endangered, and Sensitive Plant Species

Endangered plants are species in danger of extinction throughout all or within a significant portion of their range. Threatened plants are not now endangered, but are likely to become so within the foreseeable future. Sensitive plants are species not yet officially listed, but undergoing a status review.

Current Conditions

On National Forest lands in Oregon and Washington, only one plant species currently listed under the Endangered Species Act is known to occur. This is MacFarlane's four-o'clock (Mirabilis macfarlanei, listed as endangered), which grows at only a few locations in the Snake River country of Oregon and Idaho. When a listed species may be affected by planned Forest Service activities, consultation is initiated with the U.S. Fish and Wildlife Service to assure that activities will not jeopardize the continued survival of the species.

More than four hundred plant species are currently included on the Regional Forester's list of sensitive species or are considered as potential additions to that list. These species are considered to be endangered, threatened, or sensitive by the States of Oregon and Washington; or are under review by the U.S. Fish and Wildlife Service.

These species include the full range of vascular plants, from grapeferns and club mosses to orchids and grasses. They occupy a wide variety of habitats, though they tend to most often occur in less common areas such as in wetlands or riparian areas, on rock outcrops, or in soils derived from unusual parent material (such as serpentine).

Sensitive plant species can be found throughout the Region, but there are particularly high concentrations in areas such as the Siskiyou, Wenatchee, and Wallowa Mountains, and the Columbia River Gorge. The final status of these species will be determined as sufficient data are collected. In the interim, these species will be protected from management activities likely to jeopardize their survival on National Forest System lands.

Interactions

All Forest Service projects that might disturb these species or their habitat must be preceded by a biological evaluation (Forest Service Manual 2670). This process should determine whether these species or their habitats are present in the project area, and if so, whether there are potential adverse effects on the sensitive species. Mitigation measures or project modification may then be planned, as appropriate.

Cooperation With Other Agencies

The principal cooperating agency is the U.S. Fish and Wildlife Service.

Wildlife and Wildlife Habitat

Current Condition

National Forest lands of the Pacific Northwest Region are known to provide habitat for 569 species of resident and migratory, terrestrial vertebrate wildlife (174 mammals, 335 birds, and 60 reptiles and amphibians). Lists of species and habitat relationships can be found in Thomas (1979), Maser (1983), and Brown (1985).

Public demand for wildlife resources is measured by consumptive and nonconsumptive uses. Wildlife and fish user days (WFUDs) are used to report the demand for these resources. A WFUD for hunting could be the equivalent of one person hunting for 12 hours, or 12 persons hunting for one hour. Use expressed in wildlife and fish user days is determined from the best source of information available for wildlife- and fish-oriented recreation. Sources include the recreation information management data base (RIM), information from the states, and other sources.

The most recent summary of these WFUD values (Annual Fish and Wildlife Report, 1984, U.S. Department of Agriculture, Forest Service, 1984a) shows that 8.3 million WFUDs were attributed to the wildlife resource. Appendix G provides a detailed listing by Forest.

Interactions

Wildlife populations require suitable habitats for their existence. These habitats are determined by plant communities, stand conditions, stand structure, and their distribution across the landscape.

Plant communities found on sites developed due to a variety of interactions related to soil conditions, moisture, temperature, nutrient availability, elevation, aspect, and disturbance factors.

Stand condition is related to the size and density of plant species as influenced by natural and human-caused disturbances. **Stand structure** involves the vertical diversity (the various heights and kinds

of plant layers) of a plant community from the ground to the top of the overstory plant and all of the layers in between.

The interspersion (**distribution**) of plant communities, stand conditions, and interface zones between these areas create distinct environmental conditions that fulfill the habitat requirements of individual wildlife species and populations of wildlife (Brown,1985).

Changes in Habitat Condition and Suitability

Changes in habitat condition and suitability can occur abruptly (as the result of fire, windstorm, or timber harvest), or more gradually (as in the slow replacement of plant communities characteristic of succession). Some plant communities, such as wet meadows, may exhibit little evidence of change over time.

Successional Stages on Forested Sites

On forested sites, seven different successional stages (or stand conditions) are usually recognized: 1) grass-forb; 2) shrub; 3) open sapling-pole; 4) closed sapling-pole; 5) sawtimber; 6) large sawtimber; and 7) old-growth (Brown,1985). While contrasts among successional stages in the grass-shrub steppe ecosystems are less dramatic than on forested sites, similar relationships between wildlife and vegetation characteristics apply. Each successional stage in each forest community supports a characteristic grouping of wildlife species.

Riparian Area Habitat

Riparian areas (where vegetation and microclimate are influenced by perennial or intermittent water) are the transition from wetlands to upland habitats. Their influence is projected inland for considerable distances (Brown,1985).

Most riparian areas contain food, water, and cover—three critical habitat needs for all wildlife species. Riparian areas also have a greater variety of plant species composition. Their elongated shapes provide the maximum amount of interface area (edge) with the surrounding vegetation. The vertical plant diversity contains many more layers because of the abundance of understory shrubs and deciduous trees.

Riparian areas are often used for natural migration and travel corridors and provide a connecting link for wildlife moving between isolated stands. For all of these reasons, more habitat niches are provided in riparian areas and wetlands than in any other type of habitatv.



Forests of the Pacific Northwest Region provide habitat for 569 species of vertebrate wildlife. To support self-sustaining wildlife populations, an appropriate amount and distribution of suitable habitat must be maintained.

Relationship of Wildlife Species Distribution to Habitat

The use of various plant communities and stand conditions by wildlife is dictated by each specie's habitat needs. Wildlife species that are more tolerant of changes in habitat conditions are often associated

with habitats in a variety of plant communities and stand conditions.

Species with specific habitat requirements are found in close association with one or a few plant communities and stand conditions. These wildlife species are more likely to be susceptible to changes in vegetation and stand conditions.

A good example of this relationship is the dependency of the western red-backed vole and the northern spotted owl on older, closed-canopy forest stands. Their population levels could drop dramatically as stands are converted to younger age classes. In addition, clearcutting and removal of large, dead and down woody material may prevent the voles from using an area for many years.

Relationship of Wildlife Species Distribution to Stand Structure

The same is true for changes in stand structure. In a mature forested site, birds that typically inhabit the various layers range from thrushes, towhees, and winter wrens (at the ground vegetation layer) to red-tailed hawks, swallows, and flycatchers at the overstory canopy layer. In between these levels, brown creepers and nuthatches use the shrub layer while pileated woodpeckers, sapsuckers, and pygmy owls inhabit the understory canopy (Brown,1985).

Stand structure changes influence populations as well as the overall variety of wildlife species which the habitat can support.

Some Typical Wildlife and Habitat Relationships

Big game animals such as **deer and elk** use many plant communities. Grass-forb through old growth successional stages are used for forage, hiding, and thermal cover, depending on seasonal conditions. This allows deer and elk to be relatively tolerant of changes in habitat conditions. Their mobility and larger home ranges also contribute to their ability to search for necessary habitat needs.

Pronghorn antelope occur on lower elevation grass- and shrub-dominated areas east of the Cascades. Pronghorn mainly browse in sagebrush, rabbitbrush, and sagewort habitats throughout the year. Sagebrush areas provide the mainstay of their diet in the winter months. This is supplemented by forbs and grasses in the spring.

Sage grouse typically inhabit sagebrush areas that have some vegetation variety and available water. The height of sagebrush may form an important habitat requirement during breeding periods. Virtually all upland game birds require a portion of forb habitat during the spring and summer months. **Green-tailed towhees** utilize several plant communities containing various tall shrubs and/or trees.

Many of the Region's **waterfowl** are migrants, using the Central

and Pacific flyways during spring and fall. Nesting waterfowl species include mallards, goldeneyes, American wigeon, Canada geese, teal, gadwalls, pintails, shovellers, ring-necked mergansers, and lesser scaup.

Stock ponds, reservoirs, streams, and rivers provide shoreline acreage and riverbank nesting/feeding habitats required by **shorebirds**. Herons, gulls, snipe, willets, killdeer, and curlews are some of the species which use these habitats.

Raptors and scavengers: eagles, falcons, hawks, and owls are full and part-time residents of the Region, as are ravens, crows, and vultures. Cliff areas, rock outcrops, snags (dead or dying trees), and shrubs provide nesting and perch sites for many of these species.

Seed-eating and insectivorous birds inhabit riparian and upland vegetation zones. Woodpeckers and other cavity-nesting birds depend on snags for their habitat needs.

Riparian residents: as many as 85 percent of all the Region's wildlife species use riparian areas or wetlands during some seasons or parts of their life cycles. Species such as the spotted frog, beaver, muskrat, and many waterfowl species are totally dependent upon riparian or wetland areas. Other species such as the roughskin newt, ruffed grouse, striped skunk, and dusky-footed woodrat may live in other habitats but reach maximum population densities in riparian or wetland areas (Brown,1985). Many species with significant economic importance, such as most of the furbearers, are residents of riparian areas and wetlands (Brown,1985).

Species which may occupy a broad array of habitats, but at sometime during their life cycle spend a significant amount of time in riparian areas, are represented by the Pacific tree frog, western toad, Cooper's hawk, yellow warbler, bobcat, and Roosevelt elk.

Disturbances and Habitat Conditions

In the absence of human manipulation, natural landscapes support characteristic patterns of plant communities and stand conditions. These reflect, in part, the frequency of disturbances, site productivity, and successional changes that occur over time. These relationships are discussed in the Diversity section of this chapter.

Most forested sites historically experienced stand-replacing fires at intervals of several hundred years. The long intervals between such events, combined with the longevity of trees such as Douglas-fir and the fire resistance of such trees as oak and ponderosa pine, led to a landscape comprised largely of mature and old-growth stands (Harris,1984).

As a result of clearing, logging, and wildfire, much forest land in Oregon and Washington is currently occupied by younger stand conditions. Some wildlife populations will increase as forested lands return to early successional stages; those that thrive in older forests will decline.

The Columbia Plateau has grass- and shrub-dominated plant communities. Here, climate, soils, and frequent fires have tended to favor grasses over shrubs.

In the Great Basin, big sagebrush communities predominate. Fire suppression and grazing favor the dominance of shrubs and juniper, with a corresponding shift in wildlife populations. These trends have been somewhat balanced by management practices (such as brush control projects) that are intended to maintain grass/forb-dominated plant communities.

Influence of Wildlife on Distribution and Abundance of Vegetation

Wildlife variety, distribution, and abundance are influenced by vegetation, but wildlife also affect the distribution and abundance of vegetation. For example, wildlife can transport and disperse seeds, enabling plants to extend their distribution. This activity may have both positive and negative benefits, since desirable (palatable forage species) and undesirable (noxious weed seed) plant species may be transported.

Foraging by many bird species contributes to the natural control of insects which can damage conifer stands.

Grazing and browsing by wildlife can affect the growth and vigor of plants, including young trees. Wildlife species such as deer, elk, black bears, mountain beavers, porcupines, hares, rabbits, and various small rodents may have adverse effects on the survival and growth of conifers. Wildlife can also browse vegetation competing with conifer seedlings.

Wildlife species also play a vital role in dispersing the spores of fungi essential to tree growth. Maser and others (1978) found that red-backed voles and chipmunks disperse varieties of mycorrhizal fungi. These fungi attach themselves to the fine root nodes of pines, hemlocks, spruces, true firs, Douglas-fir, oaks, and alders and enable the trees to utilize nutrients from the soil which have been processed by the fungi.

Vegetation management practices may have positive and negative effects, directly and indirectly, on some wildlife species. Project analysis, at the site-specific level, helps to identify and mitigate impacts on

wildlife. Opportunities to benefit wildlife species and their habitats can then be developed and incorporated into the project design in many instances.

Cooperation With Other Agencies

Managing of wildlife populations involves a partnership between state and federal agencies. The Pacific Northwest Region has developed Memorandums of Understanding with the Oregon Department of Fish and Wildlife and the Washington Department of Game to facilitate the development of common goals and management strategies for the wildlife resource. These agreements provide opportunities for cooperative interagency planning, funding, and implementation of projects designed to benefit wildlife populations and their habitats.

Threatened, Endangered, and Sensitive Animal Species

Endangered wildlife are species in danger of extinction throughout all or within a significant portion of their range. Threatened wildlife species are those which are not now endangered but are likely to become so within the foreseeable future. Sensitive wildlife species are those not yet officially listed but which are undergoing a status review.

Current Condition

Six wildlife species currently listed by the U.S. Fish and Wildlife Service as endangered or threatened under the Endangered Species Act are known or suspected to occur on National Forest lands in the Pacific Northwest. These species and their status are listed in Table III-5.

Table III-5

Threatened and Endangered Wildlife Species

Gray wolf	*Canis lupus*	E
Grizzly bear	*Ursus arctos*	T
Woodland caribou	*Rangifer tarandus californiana*	E
Brown pelican	*Pelecanus occidentalis*	E
Northern bald eagle	*Haliaetus leucocephalus*	T
American peregrine falcon	*Falco peregrinus anatum*	E

T = Threatened E = Endangered



Six wildlife species in the Pacific Northwest Region are currently listed as threatened or endangered. Among them is the northern bald eagle.

These species differ widely in their distribution in the Northwest. The brown pelican is known only along coastal portions of the Siuslaw National Forest. Woodland caribou occur only on the Colville National Forest. In Washington, documented or suspected occurrences of grizzly bear and gray wolf have been noted in four and five Forests, respectively. Peregrine falcons are known or suspected to occur on all but three National Forests in the Region, and the bald eagle is known to have nesting, winter roosting, or migratory sites on all 19 Forests.

Thirty-six other species (eight mammals, fourteen birds, one reptile, three amphibians, and ten fish) are include on the Regional list of Sensitive Species. This list includes species considered by the states of Oregon or Washington to be threatened or endangered, and species under review by the U.S. Fish and Wildlife Service. The final status of these species will be determined as sufficient data are collected. In the interim, these species will be protected from management activities likely to jeopardize their survival on National Forest System lands.

Interactions

All Forest Service activities that might disturb these species or their habitat must be preceded by a biological evaluation (Forest Service Manual 2670, U.S. Department of Agriculture, Forest Service, 1987d). This process should determine whether these species or their habitats are present in the project area, and if so, whether there are potential adverse effects on the sensitive species. Mitigation measures or project modification may then be planned, as appropriate.

Cooperation With Other Agencies

Whenever proposed Forest Service projects may affect any of these species, consultation is initiated with the U.S. Fish and Wildlife Service to assure that activities will not jeopardize continued survival of the species. The Forest Service also cooperates with other federal agencies and state wildlife agencies in efforts to improve habitat for these species. Cooperative efforts to re-introduce some of these species into portions of their former ranges are also underway.

Fisheries

Current Conditions

The Pacific Northwest Region has approximately 15,000 miles of streams that directly support both resident and anadromous fish. There are approximately 150,000 acres of lakes and 65,000 acres of reservoirs that can support both warm- and cold-water species of fish. These aquatic habitats range from estuaries on the Siuslaw National Forest to alpine lakes along the Cascade Crest.

Resident game fish include rainbow, eastern brook, Dolly Varden, and cutthroat trout; crappie; bluegill; yellow perch; smallmouth and largemouth bass; Kokanee; and mountain whitefish. All are highly valued as recreational fish.



Streams on 15 of the 19 Pacific Northwest Region Forests provide spawning and rearing habitat for anadromous fish species such as salmon, steelhead, and sea-run cutthroat trout.

Anadromous fish (fish that spawn in fresh water and migrate to the ocean to mature) have both sport and commercial value. They are found on 15 of the 19 Forests in the Region. Pink, chum, coho, sockeye, and chinook salmon; steelhead; and sea-run cutthroat trout depend on streams in the Region for spawning and rearing habitat.

Interactions

Vegetation management activities have the potential to affect fish habitat characteristics such as water temperature; sediment load; turbidity; water quantity, and timing of flow; and the character of streamside vegetation. The quality of fish habitat is dependent upon management practices in the watershed which affect the quantity of water and sediment in the stream. Particularly important are management practices within the riparian zone (the interface between terrestrial and aquatic ecosystems).

Cooperation With Other Agencies

The Pacific Northwest Region has agreements with the Washington Department of Fisheries; the Washington Department of Game; the Oregon Department of Fish and Wildlife; and the State of California Department of Fish and Game concerning protection and maintenance of viable habitat for fish and wildlife.

Insects and Disease

Forest disease or insect populations can have a direct effect on the vigor and response of managed vegetation. The complex of pest-host interrelationships may often define the opportunities or limitations for regulation of the forest environment. This component of the environment can sometimes require suppression or control in order to achieve land management objectives.

Pests include insects, microorganisms, nematodes, atmospheric pollutants, or non-infectious disease-causing agents considered detrimental to achievement of management goals. Most forest vegetation is damaged by an insect-pathogen complex. Frequently, the stand or site conditions are predisposing factors in population buildup. The objective in pest management is to manage populations or limit damage to tolerable levels. Damage may represent an economic loss such as tree mortality, deformity, or growth loss. In other cases, it may affect resource values such as scenic quality and fuel levels contributing to fire hazard.

The extent and nature of pest populations often requiries cooperative management strategies between different private, local, state, and Federal land ownerships. Insect and disease control efforts in the Pacific Northwest Region are achieved through a decisionmaking and action process within a policy that incorporates biological, economic, and environmental evaluations of pest-host systems to manage pest populations.



Suppression or control of damaging or disease-carrying insect populations is sometimes necessary to alleviate potential economic, scenic, or recreational losses on National Forests. Shown here, patterns of galleries made by Douglas-fir beetles.

Pest management activities may involve prevention, detection, evaluation, suppression, and monitoring. The common need in forest management is to be able to accurately evaluate the seriousness of routine insect or disease problems. Management strategies must then be integrated into silvicultural and other management practices in order to limit the impact of insects and diseases.

Several forest insects are currently of management significance in the Pacific Northwest Region: the western spruce budworm; the gypsy moth; grasshoppers; and both the mountain and western pine bark beetles.

Several forest diseases are currently of management concern, including a number of root diseases (annosus, armillaria, blackstain, laminated root rot, and Port-Orford cedar root disease); various stem decays; dwarf-mistletoe; and white pine blister rust.

Land Uses

Land ownership patterns within the Pacific Northwest Region of the Forest Service are highly complex around and within National Forest boundaries. Many of the private holdings are managed for timber production by private industrial owners. State and Federal agencies (the Oregon Department of Forestry; Washington Department of Natural Resources; and the USDI Bureau of Land Management, for example) also manage large tracts of land within and adjacent to the boundaries of the Region.

The Region is comprised of 24,545,814 acres of National Forest system land (1986 figures). This land is contained within 23,894 miles of boundary. Also contained within this boundary are 2,765,197 acres of lands in other ownerships.

Smaller landowners use their land for a variety of purposes—recreational residences, organizational uses, farms, small woodlots, and small businesses, to name a few.

Generally, large, private, industrial landowners tend to emphasize uses of the environment different than those of smaller landowners. For example, large, private timber holdings are usually intensively managed for timber production; less emphasis may be put on other resources. Small landowners, on the other hand, are usually more

concerned with things such as scenic and environmental qualities, herbicide spray "drift," and noxious weed control.

Recreation

National Forests of the Pacific Northwest have highly diversified natural landscapes, ranging from seacoast to alpine meadows to desert. These offer a correspondingly wide range of recreation opportunities, from clamming to skiing; resorts to wilderness. The Forests, open year-round, receive considerable recreation use, with activities varying according to the season.

There are two Forest Service classifications for recreation: dispersed, and developed.

Dispersed recreation consists of activities that involve little interaction between users. Examples of this include hiking, hunting, and camping in undeveloped or remote locations.

Developed recreation is a concentrated form of recreation involving a range of facilities, from campgrounds to all-season resorts. Examples include family and group campgrounds and picnic areas, winter sports sites, and swimming and boating sites.

Vegetation management is used in forest recreation areas to provide for public safety by reducing fire hazards and controlling poisonous plants and noxious weeds; to improve visibility and access; and to create and maintain a natural-looking environment.

The Regional objective is to increase the supply of outdoor recreation opportunities and services through programs that emphasize dispersed recreation. Current use levels of developed or concentrated site recreation will be maintained.

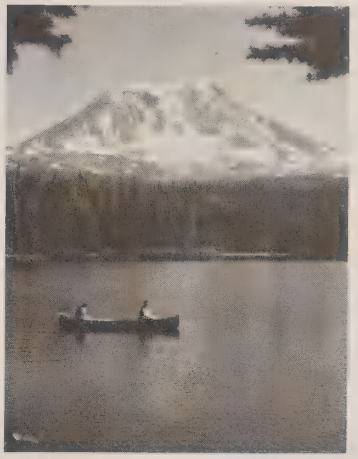
Use of the Pacific Northwest Region's (slightly over 1,900) developed recreation sites currently equals over 13 million Recreation Visitor Days (RVD's). A Recreation Visitor Day is defined as being equal to 12 hours spent by a visitor. This figure includes RVD's at Forest Service operations; permittee operations; and privately-owned sites within National Forest boundaries.

Historically, the Forest Service has expended approximately two percent of its annual recreation operation and maintenance budget to

control vegetation in developed recreation sites. For Fiscal Year 1985, this amounted to slightly over $200,000. This trend is expected to continue.

Dispersed recreation accounts for over 18 million Recreation Visitor Days on approximately 1,700 dispersed recreation areas. Because of the nature of dispersed recreation, very little vegetation management takes place in these areas. While dispersed recreation will likely increase in the future, there will be an almost-negligible increase in vegetation management.

Vegetation management techniques presently (and historically) used in recreation sites consist almost exclusively of manual and mechanical means. Herbicides (when allowed, prior to the injunction) have been a preferred treatment for poison oak and other toxic plants, as both cutting and burning expose employees to toxic effects and generally afford only temporary results.



Diverse natural landscapes in the National Forests offer hundreds of recreational opportunities.

Wilderness

The Pacific Northwest Region presently administers 4,678,915 acres of designated wilderness. Wilderness is a unique and vital resource. In addition to offering primitive recreation opportunities, it is valuable for its scientific and educational uses, as a benchmark for ecological studies, and for the preservation of historical and natural features.

There are opportunities for recreation and scientific study in conditions as diverse as the alpine, high elevation environments of the Alpine Lakes or Eagle Cap Wildernesses, or the canyon country of the Wenaha-Tucannon or Wild Rogue Wildernesses. The rugged natural environments and typically large size of wildernesses combine to provide a recreational experience with a high probability of isolation, in a setting that offers a high degree of challenge.

Management activities in wilderness areas are outside the scope of the decisions being made with this EIS.

Facilities

Forest Service facilities range from buildings and compounds constructed around the turn of the century, to modern, state-of-the-art research labs and offices. Vegetation management provides protection to buildings and property, safe working conditions, and an aesthetically pleasing appearance for the facility.

Historically, less then one percent of the total facilities maintenance budget has gone to vegetation control. Work consists primarily of grounds maintenance: lawn and shrub care, and control of blackberry, morning glory, poison oak, and other weeds. Moss buildup on roofs and sidewalks is also a problem that must be dealt with in the Pacific Northwest Region.

Current efforts to control vegetation have generally been considered adequate, and it is estimated that this level of maintenance will continue in the future. Loss of herbicide use to control weeds and moss has not had a major effect on facilities maintenance. Some of the work has been done by manual methods (cutting weeds by hand, for example), and other areas have been temporarily ignored (some poison oak control, and moss buildups). These problems will eventually have to be corrected, but are not considered major problems.



The Forest Service currently maintains nearly 88,000 miles of roads in the Pacific Northwest Region. Roadside vegetation has been controlled using chemical, mechanical, manual, and biological methods.

Rights-Of-Way Maintenance

Forest Service Roads

Forest roads are of primary importance for the protection, administration, and utilization of the National Forests and other areas administered by the Forest Service.

The Forest Service currently maintains almost 88,000 miles of roads in the Pacific Northwest Region. Approximately 15-20 percent of the annual road maintenance budget is spent on managing competing and unwanted vegetation. At present, the Region has over 30 percent of roads open to motorized vehicles in a "not maintained to standard" category. Much of the maintenance that is not to standard is in the area of roadside vegetation, especially on those Forests west of the Cascades.

The Regional budget for road maintenance decreased until this past year. This has resulted in fewer dollars available for vegetation management, and a corresponding increase in the backlog of work to be done. Several West-side Oregon and Washington Forests have had to allocate a larger percentage of their maintenance dollars to vegetation management, and are still falling behind on their brush control work since the injunction against herbicide use has been in effect.

The Region currently constructs approximately 900 miles of road each year, which generates about 4,500 acres of vegetative debris requiring disposal. The majority of the debris is scattered along the roadside and left for firewood or to decompose. About 700 to 800 acres per year is piled and burned during the construction operations. Other options used for clearing debris are windrowing, burying, chipping, removal, piling, and placing on embankment slopes.

Highways

Roads and highways within the National Forests of Oregon and Washington that are managed by other agencies (county, state, and Federal) are of primary importance for access and transportation of goods and services. These agencies maintain approximately 4,300 miles of roads and highways (over 34,000 acres) within the National Forests of Oregon and Washington.

Historically, roadside vegetation along these roads has been controlled using chemical, mechanical, manual, and biological methods. Vegetation management is performed on road shoulders to enhance drainage of surface and subsurface water; on cut slopes and fill slopes to provide increased sight distances; to prevent icy spots from forming due to roadway shading; and to provide for rights-of-way vegetation control of danger trees along roadsides.

Utility Corridors

Many public and private utilities have rights-of-way through the Region's National Forests. Power line and communication utilities have above-ground and buried cable line rights-of-way and access roads; towers; and substations and relay stations.

Vegetation management is performed on the above to enhance the reliability of the transmission system, and to provide safety for those working around the facilities.

In some areas, the repeated control of tall-growing vegetation tends to encourage low-growing species to flourish and spread, while in other areas, tall-growing species will perpetually return, necessitating periodic control.

In forested areas, cleared rights-of-way may function as limited fire breaks and provide access for the control of wildfires. In developed areas, transmission line rights-of-way may function as desirable open space, recreational areas, or storage areas.

Railroads

The main goal of vegetation management for railroads is to prevent train-caused fires along the right-of-way. Other objectives include maintaining the roadbed; eliminating safety and nuisance problems for railroad personnel; maintaining ditches and other drainage structures; and providing increased site distance at railroad crossings.

Railroads have rights-of-way, access roads, crossings, and communication lines throughout Oregon and Washington that require annual vegetation control. This involves approximately 105 miles (over 2,400 acres) within National Forest lands in the Pacific Northwest Region.

Trails

Trails provide outdoor recreation opportunities for the Nation, as well as access to scenic and cultural resources within the National Forest System. Vegetation along these trails is controlled to provide for user safety, as well as to protect the investment.

Vegetation is generally cleared two to four feet on each side of the trail tread to varying heights, depending on the intended use of the trail.

Most vegetation clearing is done manually, with some mechanical work also performed. Chemical treatments are rarely used.

Land Line Location

In order to delineate property lines and administrative boundaries, the Forest Service has implemented a land surveying program that identifies, marks, posts, and maintains legal property lines.

While identified property corners are marked and then maintained periodically to preserve them, few actual miles of property lines are maintained on a regular, prescribed basis. Approximately 150 miles of line will be maintained this year, which amounts to less than 100 acres. By 1990, the Region expects to have increased this to about 800 miles (approximately 400 acres) of land line maintenance per year. Manual methods of vegetation control are nearly always used.

Scenery

The Pacific Northwest Region contains scenic landscapes that vary from coastal rain forests and snow-covered mountain peaks to open rangelands.

A program has been developed for managing the scenic quality of the visual resources of the National Forests. Vegetation management provides an opportunity to maintain or enhance them.

The program includes a comprehensive evaluation of (1) scenic quality (variety); (2) level of sensitivity (people's concern for scenic quality); and (3) viewer positions relative to forest lands. A series of recommended visual quality objectives for each specific area are derived from these considerations.

Distinct visual character types are found in the Region. These are functions of landform, vegetation, water forms, rock formations, and natural processes. For management purposes, scenic quality within each character type is rated as:

- distinctive (unusual or outstanding visual quality);
- common (features exhibit variety in form, line, color, and texture, but are common in the character type); or
- minimal (little visual variety).

Factors affecting landscape appearance include canopy characteristics; diversity of vegetation species; natural openings (such as meadows or rock outcrops); soil color (including lightness or darkness); and slope.

Scenery—for planning, design, and management purposes—is divided into foreground, middleground, or background. These are all relative to the viewer's distance from a given landscape. By changing location, an area's classification and scenic importance may change. Thus, all roads, trails, use areas, and water bodies are evaluated for user sensitivity (high, medium, or low) based on the type and volume of use, the duration of use, and the recreation importance of the road or site.

Scenery is managed to meet objectives which describe differing degrees of acceptable alteration of the natural landscape. Specific discussions of each objective can be found in the National Forest

Landscape Management, Vol. II, Chapter 1, USDA Handbook No. 462, on file at the Pacific Northwest Regional Office.

In some of the objectives, management activities are visually subordinate to the natural landscape character, and the natural character is dominant. In others, management activities are allowed to dominate the natural landscape.

Some landscapes vary in their capability to absorb the impacts of similar management activities. Thus, the same actions may result in different effects on various landscape types. Vegetation management treatments may have to be modified to meet visual quality objectives, particularly in more sensitive landscapes with low or moderate capability for absorbing these impacts.

Cultural Resources

Cultural resources are artifacts, buildings, or sites resulting from human activity in a past era. They can be archaeological (generally associated with Native Americans), or historical (associated with early settlement and development). Examples of cultural resources are



Cultural resources—artifacts, buildings, or sites—are finite, irreplaceable resources. Federal laws and formal procedures assure their protection and preservation for future generations.

remnants of foot paths and wagon roads; abandoned trading posts; and abandoned homesteads.

Cultural resources are finite resources and are unique in that they are irreplaceable. They can have historical, archaeological, architectural, scientific, informational, or cultural values of great interest and concern to the public. Faced with the possible loss of these important treasures, Congress has acted to protect them by passing such laws as the Preservation of American Antiquities Act of 1906; the National Historic Preservation Act of 1966, amended in 1980; the Archeological Resource Protection Act of 1979; Executive Order 11539; and the American Indian Religious Freedom Act.

These laws and regulations require Federal agencies to manage the significant cultural resources under their control. To accomplish this, a combination of inventory, protection, and enhancement actions are used. The cultural resource laws and regulations provide specific procedures that must be followed to assure that cultural resource values are considered in any decisionmaking process. Compliance with these procedures requires the land manager to accomplish a series of tasks that includes inventorying, evaluating, determining effects, and mitigating adverse effects.

Prior to initiating any proposed vegetation project, a reconnaissance survey is required to obtain an inventory of cultural values. These might include any special local uses of the area by Native Americans for spiritual or cultural activities. Some keys for identifying cultural resource sites include such subtle things as differences in native vegetation; exotic vegetation; or excavations.

Public Health

As of 1984, approximately 7 million people resided in Oregon and Washington (combined). Washington's recorded population was 4.35 million people; Oregon's was 2.67 million. People in the region enjoy above-average good health, compared to the total U.S. population.

The overall 1982 death rate per 100,000 in Washington was 755.4; in Oregon 810.1; and in the U.S., 852.0. The figures for cancer deaths were 171.0; 179.4; and 187.2, respectively.

In contrast, the death rates from accidents were 41.4 in Washington; 41.6 in Oregon; and 40.6 nationally.

The Forest Service estimates that 100,000 people live within one

mile of the National Forests (including 30,000 who live within a quarter-mile). The Forest Service reports a trend of increasing numbers of residents near National Forests.

This increasing proximity of people living near lands managed by the Forest Service has resulted in increasing public concern with environmental issues such as air and water quality and public health. In particular, health concerns have been raised about 1) use of pesticides and 2) smoke from fires.

Herbicide Use

Currently, no herbicides are being used in the Pacific Northwest Region of the Forest Service. Until 1982, however, the Region used herbicides to control unwanted vegetation in its forests, rangelands, and along rights-of-way.

Sixteen herbicides have recently been used by the Region and are currently being considered for potential future use. In the past, four of these accounted for the bulk of use. The remaining 12 were used on less than 5 percent of the acres treated. The herbicides 2,4-D and Glyphosate each accounted for roughly one-third of the total acres sprayed (see Table III–6 and Appendix D).

The Forest Service has historically sprayed about 40.6 thousand acres per year (less than two-tenths of one percent of the total land area). Two-thirds of this was for silviculture (site preparation and release), with another one-fifth used for rights-of-way maintenance.

Historically, approximately 600 workers were involved in approximately 12,000 person-days of herbicide spraying. More than 200 workers (approximately 3,000 person-days) were involved in spraying for silviculture purposes. Table III-7 shows average numbers of workers used for various programs.

Table III-6

Forest Service Herbicide Use Before 1982, Pacific Northwest

	Herbicide	Percent of Treated Acreage
Major use	2,4-D	Approx. 38%
	Glyphosate	Approx. 31%
	Picloram	Approx. 8%
	Triclopyr	Approx. 7%
Minor use	Dalapon	Less than 5%
	Atrazine	Less than 5%
	2,4-DP	Less than 5%
	Hexazinone	Less than 5%
	Fosamine	Less than 5%
	Dicamba	Less than 5%
	Asulam	Less than 5%
	Tebuthiuron	Less than 5%
	Diuron	Less than 5%
	Simazine	Less than 5%
	Bromacil	Less than 5%
	Amitrole	Less than 5%

Table III-7

Average Numbers of Workers for Herbicide Application Activities, by Type of Application

Silviculture—Aerial (Helicopter)
Requires 20-25 workers (one pilot; one contractor's representative; ten flaggers; three inspectors; two or three traffic control law enforcement officers; three to five water monitors; one general support person; and one radio technician).
Total Yearly Workers: 200-250 (2,500-3,500 person-days)
Silviculture—Ground (Backpack Spray and Hand Application)
Requires 12-15 workers (one contractor's representative; one foreman; five or six crew members; one inspector; two to four general support workers; and two or three monitors).
Total Yearly Workers: 100-150 (3,800-4,300 person-days)
Range Improvement—Aerial (Fixed-wing Aircraft)
Requires five workers per project (one pilot; one contractor's representative; a Forest Service administrator; and two flaggers).
Total Yearly Workers: 25-30 (300-350 person days).
Noxious Weeds—Ground (Backpack Spray and Hand Application)
Requires one or two licensed applicators per project.
Total Yearly Workers: 140-150 (1,500-2,200 person-days).
Rights-of-Way—Ground (Truck or Backpack Spray)
Requires three workers (one driver; and one or two applicators).
Total Yearly Workers: 100-125 (3,000-3,500 person-days).
Facilities Maintenance—Ground (Backpack Spray and Hand Application)
Requires three workers (one supervisor and one or two applicators).
Total Yearly Workers: (approx. 50-60 person-days).

Social and Economic Conditions

The area of influence for the purposes of this report—the people and communities most directly influenced by National Forest vegetation management activities and outputs of the Pacific Northwest Region—comprises the states of Oregon and Washington. The social and economic conditions of these two states, and their principal ties to National Forests in the Region, are described below.

The Region, West and East

Oregon and Washington contain a great variety of land forms that reflect the results of water, volcanic, and glacial events. The major geological feature is the Cascade Mountain Range, which parallels the Pacific coastline about 100 miles inland. This rugged range divides the Region into two distinct zones. Climate, vegetation, the economy, and population patterns are different on the west and east sides of the Cascades.

The West-side

The western part of the Region has 5.7 million people. It contains the majority of the population of the two states. Eighty-seven percent of Oregon's population and 69 percent of Washington's population reside west of the Cascades. Population centers are concentrated along the Puget Sound in Washington, and the Willamette Valley in Oregon.

They are linked by north-south Interstate Highway 5, and by the Southern Pacific, Burlington Northern, and Union Pacific railroads. Major ports on Puget Sound and the Columbia River provide trade links to the Pacific Ocean nations.

The economy of the western portion of the Region is relatively diversified; more so in Washington than in Oregon, however. Aircraft manufacturing, shipbuilding, forest products industries, major financial centers, service and trade centers, educational centers, government, commercial fishing, agriculture, the livestock industry, recreation facilities, and mining all contribute to the economic picture.

The East-side

The eastern part of the Region is two-thirds of the land area of Oregon and Washington. It contains a smaller proportion of the population: about 13 percent of Oregonians and 31 percent of Washingtonians live east of the Cascade Mountains. Oregon has no metropolitan areas on

the East-side; Washington has the Yakima, Tri-Cities, and Spokane Standard Metropolitan Statistical Areas (SMSA's).

Major transportation linkages include Interstate Highway 90 and the Burlington Northern Railroad (providing east-west transportation), supplemented by the Columbia River corridor, with rail, Interstate Highway 84, and barge transportation. The remaining East-side area is not as well served.

The economy of the eastern portion of the Region depends more on agriculture, forest products industries, and the livestock industry than does the western portion. The relative dependence on these sectors has not been balanced by growth in other major employment sectors, except for some localized growth in recreation and service industries. The East-side has fewer opportunities for employment. The cities and towns reflect a rural-based economy with little diversification.

The Pacific Northwest is a Region in transition—transition which is necessarily moving the region to a more diversified economic base. The traditional employment sectors simply do not have the same labor requirements as they did in the past. Many felt that the natural wonders of the area would be sufficient to guarantee its growth. Actually, growth has declined markedly, as shown in Table III-8.

Population

Table III–8

Population Size and Growth Rates
Oregon and Washington

				Average Annual Rate of Increase (Percent)	
	1960	1980	1986	1960-1980	1980-1986
Washington	2,853,214	4,130,163	4,419,700	1.9	1.1
Oregon	1,768,687	2,633,149	2,659,500	2.0	0.2
Total	4,621,901	6,763,312	7,079,200	1.9	0.8

Source of 1960 and 1980 Data: 1980 Census. 1986 Oregon data calculated from Table 3 of Population Estimates of Oregon, Counties and Cities, July 1, 1986, published by the Center for Population Research and Census, School of Urban and Public Affairs, Portland State University. 1986 Washington data calculated from Table 9 of 1986 Population Trends for Washington State, August, 1986, published by the Office of Financial Management of the State of Washington.

The population of Oregon and Washington was 6,763,312 in 1980, an increase of over 2 million people in two decades, equaling a 1.9 percent annual growth rate. Since 1980, the annual rate of growth has slowed to 0.8 percent, with the great bulk of it occurring in Washington.

Urban/Rural Population

There are significant differences between Washington and Oregon in the distribution of population. Washington contains 61 percent of the Region's population; the vast majority of these residents live in urban areas. There are five metropolitan areas in Western Washington—Bellingham, Seattle-Everett, Bremerton, Tacoma, and Olympia. Three more are east of the Cascades—Yakima, Spokane, and Richland-Kennewick-Pasco.

Oregon's population, with 39 percent of the Region's total, is also primarily urban. The state has four metropolitan areas, all on the west side of the Cascades—Portland (which includes Vancouver, Washington), Salem, Eugene-Springfield, and Medford. Table III-9 shows the 1980 distribution of population between urban and rural areas.

Table III-9

Population Distribution—Urban and Rural, 1980

	Urban
Washington	74%
Oregon	68%

Minorities

Racial and cultural minorities are a small segment of the two states' population. In 1980, Blacks comprised 2 percent of the population; American Indians 1 percent; Hispanics 2 percent; and Asians 2 percent. Blacks in the Region are predominately urban in their residence, while Native Americans and Hispanics are more rural than the overaThere are over 20 Indian Reservations in the two states. Many are adjacent to National Forests, and Native Americans have significant concerns about Forest resources and management.

Age, Sex, and Labor Force Participation

The age composition of the Region's population has shifted since 1970 in that a larger proportion of the population were of working age by 1980. A significant increase in the number of women in the labor force occurred for women aged 16 and over—from 43 percent to 52 percent. As the age structure of the Region continues to shift, the size and other characteristics of the labor force will be impacted (BPA, 1982).

The Economy

The Pacific Northwest has a history of dependence on resource-based industries. Diversification, an ongoing process, is more advanced in Washington than in Oregon. The Pacific Northwest Region is noted for its environmental quality, is located favorably for foreign trade, and has a well-educated work force.

The major centers of growth and diversification are in the Puget Sound, Spokane, and Willamette Valley metropolitan areas. While employment in agriculture and lumber and wood products has declined over time, the natural resources of the Region will continue to play an important role in its economic base. Table III-10 summarizes recent area employment.

Table III-10

Employment in Oregon and Washington in the Mid–1980's
(Thousands of Jobs)

	Oregon	Washington	Total
Total (100%)	1,210	1,617	2,827
Lumber & Wood Products	64 (5.3%)	41 (2.5%)	105 (3.7%)
Paper & Allied Products	9 (0.7%)	16 (0.9%)	25 (0.8%)
Agriculture, Forestry, and Fishing	23 (1.9%)	44 (2.7%)	67 (2.4%)

Oregon data for the above table are for 1985. They were taken from page 2 of Oregon Industrial Outlook, published by the Employment Division, Department of Human Resources, State of Oregon (RS PUB 78 (5-86)). Washington data for the above table are for 1984. They are taken from page 113 of Employment and Payrolls in Washington State by County and Industry, Fourth Quarter 1984, No. 153, January 1986.

Data from the two states are not necessarily comparable, due to differences in definitions. Data shown represent covered employment, and thus are exclusive of proprietors, family-member work on farms, and others.

Lifestyles, Attitudes, Beliefs, and Values

Many people find the Pacific Northwest to be an appealing place to live. To some extent, that finding has been translated into the location of new enterprises in the area. As much as anything else, though, the 1980's are likely to be remembered as the time when the Pacific North-

west realized that its continued growth would not come about without effort—that it would have to work to attract suitable employers, and that other locations in the nation were also viewed as being desirable places to live and work.

Certainly, there is no one Regional lifestyle or set of attitudes, beliefs, and values. Such generalizations are inaccurate today, just as they were in the past. Continuing improvements in technology have helped shift the metropolitan economies from their historical resource bases to more diversified bases. Strong environmental concerns have developed which are not restricted geographically or by occupation.

Because the economies of the rural communities are more typically associated with commodity production, residents of those areas are frequently perceived as being more likely to favor higher production levels and heightened development. Residents of metropolitan areas, whose livelihoods are not directly or noticeably linked to the extraction of natural resources, are more commonly viewed as favoring environmental concerns. The relationship is not that cut-and-dried, of course, as is demonstrated, for example, by a 1986 public opinion survey conducted by the Oregon State Board of Forestry.

Vegetation management affects lifestyles, attitudes, beliefs, and values directly—as people see the Forest Service taking action or adopting a "no action" posture relative to vegetation management—and indirectly as decisions on vegetation management are ultimately reflected in changes in timber harvest levels and other Forest outputs and activities.

Environmentalists live in rural areas as well as in metropolitan areas, just as do those who favor development of the resource base. Too, there is no simple line of demarcation between these camps. Environmentalists are concerned about their neighbors' jobs, and millworkers are frequently among the first to note their concern for the environment.

The economy of the Pacific Northwest is slowly but surely moving toward more diversity, away from its historic dependence on the extraction of natural resources, and the initial manufacturing of them. With that change comes a greater regional resilience to economic cycles, and an increasingly important role for National Forests as places of recreation, natural diversity, and high environmental quality. Within that context of change may be additional changes stemming from the alternative ways of managing vegetation management proposed in this EIS.

Chapter IV

Environmental Consequences

Chapter IV

What Reviewers Said	Our Response
1. Local timber harvest level adjustments predicted for the first Forest Plan decade should be presented.	1. To address first decade timber harvest levels, we developed and added allowable sale quantities (from the proposed Forest Plans). We also show potential yield estimates from existing plans. The summary of the data from each Forest is shown under Timber Yield Effects.
2. Forest level timber harvest effects (ASQ) and economic effects are needed to display local impacts.	2. We now include a summary of Forest-by-Forest timber harvest effects. We are also using Forest-by-Forest allowable sale quantities to represent local economic effects. See Chapter IV.
3. Replace the IMPLAN model with a more complete, up-to-date economic model.	3. We believe the IMPLAN model is the only appropriate one to use in this analysis. We stayed with it but explained why in text. See Appendix B.
4. A serious basic flaw in the entire VMDEIS is the reliance and incorporation of the preferred alternatives from the as yet, uncompleted Forest Plans for the 19 National Forests in the Region.	4. Preferred alternatives from the draft Forest Plans provide one estimate of a Region-wide likely future. We decided to stay with the data from Forest plan preferred alternatives for many analyses. Where current plans may provide different effects, analysis was conducted using both current plan data and preferred alternative data under the new plans. One example is the predicted change in allowable sale quantity for each National Forest, shown in tables in the Timber Yields section in Chapter IV.

What Reviewers Said	Our Response
5. The whole noxious weeds section is not well developed and not enough information is provided.	5. The noxious weed material is discussed in more detail in the Rangeland Vegetation sections of Chapters III and IV.
6. Risks to wildlife should be displayed. Effects on wildlife are underplayed and invertebrates are neglected.	6. We revised the Wildlife and Wildlife Habitat sections and added a wildlife appendix (Appendix J) that discusses effects of herbicides, wildlife risk, and available literature. The Diversity section also contains information regarding the importance of food chain components to the overall ecosystem.
7. Buffer widths are too wide. Buffers are not big enough.	7. Neither our analysis nor public comment provided any rationale to change the buffer widths. However, we have provided a more complete explanation concerning buffers in Chapter IV, Water Resources; herbicide section.
8. There should be no spraying of herbicides in municipal, domestic, or fish hatchery supply watersheds.	8. We think there will be times when herbicides should not be used in these areas, and times when some of them could be. Therefore, we developed a new policy that requires a site specific analysis (including a project risk assessment) for each project. See Chapter II.
9. Add more clarification of the relationship of the Vegetation Management EIS Forest Land Management Plans, and the Regional Guide. The specific concern is the use of even-aged systems in timber management.	9. We added clarification of the relationship of the EIS, Forest Plans, and the Regional Guide to the Timber Yields section. This material includes policy guides on even-aged management and clearcutting.

What Reviewers Said	Our Response
10. The treatment of the whole human health risk topic is too technical and confusing.	10. We developed a new clear, brief summary of human health risks. It is written in everyday language and appears as a stand-alone appendix to the FEIS. It is called the Characterization and Management of Risk.
11. The Human Health section of Chapter IV is very difficult to understand.	11. The explanation of human health effects has been replaced by the clearer material and tables from the new human health risk summary.
12. It is not clear how you will use the findings of the two human health risk assessments in everyday vegetation management operations.	12. The FEIS now shows a direct connection between the risk assessments in the appendices, the conclusions about human health effects in Chapter IV, and the management of risk through the mitigation measures in Chapter II.

Chapter IV

Environmental Consequences

This chapter presents the environmental consequences that would occur if the alternatives and vegetation management methods presented in this EIS should be implemented.

It provides the information that is the basis for the comparison of alternatives presented in the last part of Chapter II.

How the Chapter is Organized

The chapter opens with two general background discussions: one on how the effects were estimated, and one on how uncertainty was addressed in that analysis. The remainder describes the environmental consequences of the alternatives. The chapter closes with summaries of the most important significant effects.

Background

Estimating Environmental Consequences

Environmental consequences (or effects or impacts—we use the terms interchangeably) occur when ecosystems are changed, whether through management action or inaction. Under each alternative, we would manage problem vegetation in a different way. In this chapter, we present the environmental consequences of those different management alternatives.

The core of the chapter is organized by environmental components, such as "soils," "wildlife," and "social and economic effects." Each section starts with the management changes that would affect the resource. Next, direct environmental effects are discussed, along with the reasons they occur. Changes in one part of the environment often lead to changes in other parts. These indirect effects are presented also.

Small changes happening repeatedly in the same place—or in a lot

of places—may have a large effect. These cumulative impacts are discussed where they are foreseen. Where impacts would conflict with the plans and policies of other agencies, those conflicts are presented.

All the alternatives specify ways to avoid, reduce, minimize, and rectify potential adverse impacts. These are called "mitigation measures". In estimating environmental effects, these measures are assumed to be in place and to be effective. Where appropriate, the different sections will indicate known experience with these mitigation measures, their dependability, and the consequences should they fail.

Site-Specific Environmental Effects

The vegetation management program involves hundreds of site-specific projects across the Region over several years. The environmental consequences of each one of them will be different, depending on the characteristics of the land, vegetation, and animals on that site; the weather and the time of year; and on how the activity is conducted.

In this environmental impact statement, the environmental effects are generally presented as Regional effects, with special attention given to effects that vary predictably by subregion.

When the site-specific environmental analysis finds that the action would significantly affect the quality of the human environment, an environmental impact statement is prepared.

Regional Environmental Effects

The Pacific Northwest Region has a large number and variety of vegetation needs in a large variety of plant communities and ecological settings. The problem faced by the interdisciplinary team was how to estimate the environmental effects of a complex Region-wide program in such a complex environment.

Resource managers and specialists on the individual National Forests are in the best position to know the extent and nature of vegetation management needs on their Forests. The team decided to draw on this knowledge, using the expertise from all 19 National Forests to help identify the extent, nature, and costs of vegetation management associated with each alternative.

This information about each alternative (combined with the interdisciplinary team's knowledge of ecological processes, research literature, and forest management experience, and information provided by members of the public and cooperating agencies) was the basis for

estimating the Regional environmental impacts of the alternatives.



The expertise of resource managers and specialists from all 19 National Forests of the Pacific Northwest Region was used to help identify the extent, nature, and costs of vegetation management associated with each alternative presented in this EIS.

This analysis of environmental effects and resource management was greatly aided by frequent contact with Forest Service resource specialists and scientists, and by their participation in the reviews of rough drafts of the environmental impact statement.

Much of the material on human health effects was compiled, analyzed, and reviewed by members of the University of Washington Department of Environmental Health and Labat-Anderson, Inc.

Silvicultural analysis and other parts of the document were reviewed by faculty at the College of Forestry, Oregon State University. (While their endorsement is not implied, their comments were helpful to the interdisciplinary team.)

The "Reference"

The environmental consequences of different alternatives can best be analyzed, described, and compared by noting their differences from a common future—a "reference" line or point.

To estimate the effects of the alternatives on Regional programs and the environment, a reference was needed. This reference would describe probable levels of activities, production, and environmental conditions. The levels and specifications of the Region's proposed Forest Plans (as presented in both published proposed Plans and pre-publication drafts) were used as that reference.

The alternatives in this EIS look forward. None seek to replicate management conditions of the past. All are equally applicable to implementing current or future Forest Plans.

Alternative B specifically uses the same assumptions and levels as the proposed Forest Plans. It represents the reference or "likely common future" for this EIS.

When information was requested from the National Forests on the management and environmental effects of the vegetation management alternatives, it was in terms of changes from Alternative B. Alternative B was the sum of all 19 Forests' best estimates of activities that would occur once their respective Forest Plans were implemented.

We recognize the strong likelihood that our reference will change as Forest Plans are developed. Public comments on the proposed Forest Plans, changes to improve the analysis, and changes in Regional Guide direction will cause these Forest Plan levels to vary. The Forest Plans may be affected by this vegetation management EIS, for instance.

However, as Forest Plan activities and outputs vary, they cause similar effects on all the vegetation management alternatives. In much the same way that a rising tide lifts all boats, changes from the currently estimated production levels and environmental conditions would be reflected in similar changes in the levels estimated for our alternatives.

The important dimension is the direction and extent that vegetation management alternatives vary from a common, reasonable condition. If that common condition does not precisely predict the future, it does not detract from the analysis and comparison of the alternatives in this EIS.

Types of Effects Estimated

The National Environmental Policy Act (NEPA), while incorporating social and economic effects, places a clear emphasis on impacts to the physical and biological aspects of the environment. This emphasis is reflected in our document. Because of public and management concerns about economic, social, and health effects, we present them also, though they may not be specifically required by NEPA.

How the Effects were Estimated

Starting in October and November of 1986 the interdisciplinary team, with the assistance of interested members of the public and cooperating agencies, identified the information needed to disclose and compare the environmental and management implications of the alternatives in this environmental impact statement.

Each alternative needed information that would show:

- the environmental effects (including effects on public health);
- the amount of work that would be done on the National Forests;
- the cost of that work; and
- the goods and services that the National Forests would provide.

How would an alternative be implemented on the National Forests of the Region? Scientific literature provides a basis for tracing the effects, results, and risks associated with specific activities. However, the extent to which those activities would be used in any single alternative was not known.

What would be the mix of tools? Some vegetation management tools can be substituted for others, but their relative effectiveness varies, as do their implications for other resources and programs in the multiple-use mission of the Forest Service.

Information about the alternatives needed to incorporate an integrated view of resource management, and consider the ecology and the management goals of each National Forest. Estimates had to be made as to the levels of activities and outputs associated with the various alternatives.

Common definitions for the various vegetation management activities and resource and amenity outputs were essential. An activity identified on the Colville National Forest had to be comparable to one noted for the Rogue River National Forest, for instance. Likewise, there needed to be a common period used to compare the activities, costs, and effects associated with each alternative.

The need for common definitions was met by the Management Information Handbook, which provides a codified set of definitions for Forest activities and outputs. Information on the levels of cost associated with different activities and their related outputs are contained in the Forest's budget proposals. Information for these proposals was generated by the respective National Forests and validated, where necessary, through discussion with Regional Office specialists.

In total, these information requirements clearly indicated that the interdisciplinary team would need to work closely with the National Forests in the Region.

The interdisciplinary team chose the budget proposed for Fiscal Year 1989 as the baseline for data collection and analysis. It is the most

current and comprehensive data base.

Alternative B is the summation of the individual Forests' 1989 proposed budget programs. It is the baseline for this analysis. The management and environmental consequences of implementing any alternative are expressed as differences from Alternative B.

The budget level proposed for Alternative B is not substantially different from other budget proposals in recent years. It forms the basis for a realistic estimate of Forest programs. The environmental and management effects of the vegetation management alternatives relative to each other are not significantly affected by probable changes in the budget levels.

In December 1986, the interdisciplinary team sent a detailed questionnaire to each of the 19 National Forests in the Region. It contained an explanation of the work being done for this analysis; a presentation of the alternatives; a list of questions regarding vegetation management; a list of items needed to establish a detailed data base for analysis of fire and forest fuels; and the budget matrix for the 39 line items potentially involved with vegetation management activities. (In total, the questionnaire package comprised 54 pages. A copy as it was sent to the National Forests is available upon request from the vegetation management group. See the cover sheet of this document.)

The data from the Forests were examined in detail by specialists on the interdisciplinary team. Where clarifications were needed, or where data were inconsistent, the team specialists coordinated any needed revisions with the appropriate specialist(s) on the National Forests and cognizant resource specialists in the Regional Office. Regional Office resource managers played a key role in contributing to the team's understanding of their programs in the future.

The Regional consequences of the alternatives (both management and environmental) were developed from these data sources. The data were entered into electronic spreadsheets for analysis.

The different consequences of the alternatives are generally presented as Regional totals. This is appropriate to the scope of the document, as it establishes a Regional program. As previously noted, the environmental consequences for specific vegetation management projects will be analyzed in site-specific environmental analyses.

Incomplete or unavailable information was sometimes encountered in the process of preparing this EIS. The implications of these situations and how they were handled are discussed next.

Incomplete or Unavailable Information

The purpose of the environmental analyses contained in this EIS is to "present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decision-maker and the public" (40 CFR 1502.14).

Uncertain Data and Estimates

Data and information collected for the various analyses in this EIS, as well as the resulting estimates of effect and conclusions, vary in precision and accuracy. Some are based on censuses and many mutually-confirming studies. Others are based on samples and a few studies; some are estimates by professional specialists drawing on extensive experience with individual disciplines. The standard for determining the depth of analysis is that analysis be sufficient to provide "a clear basis for choice among options": in this case, a choice among the seven alternatives considered in this EIS.

Uncertainty in data and information is often the result of the inherent variability of natural phenomena. Uncertainty due to inherent variability can be expressed through a variety of means including statistical measures of variation, estimates of ranges, and qualitative descriptions.

Sometimes, uncertainty is the result of incomplete or unavailable information. If the information that is incomplete or unavailable is essential to the decision to be made (in this case, selection of one of the eight alternatives considered in this EIS) then a more rigorous standard for analysis and reporting is required by law (40 CFR 1502.22). The more rigorous standard specifies an orderly, careful, and open professional approach in dealing with uncertainty. It is summarized in Figure IV–1. This approach replaces the old worst case analysis regulation. For purposes of this EIS, the worst case analyses codified in the old regulation are also included.

Reasonably Foreseeable Significant Adverse Effects

In preparing this EIS, an open public process was used to identify significant issues. Three of the seven issues identified are issues because of the potential for reasonably foreseeable significant adverse impacts on the human environment. The potential impacts are in the areas of human health, social and economic effects, and environmental effects. See Chapter I and Appendix I for discussions of the issues and the scoping (issue information gathering) process.

Economic Impacts

Vegetation management will affect the Forest Service's ability to provide goods and services and payments to local governments. An alternative's impacts on these can be reasonably estimated. These estimated effects are reported later in this chapter. The effect of these changes cause changes in employment and income. These can also be estimated; and are reported in the Social and Economic Effects section of this chapter. In the area of social and economic effects, there is sufficient information to provide a clear basis for making a choice among options with confidence.

Environmental Impacts

Environmental effects are reasonably well understood. The uncertainty associated with estimating environmental effects is due to the (often great) inherent variability and diversity associated with the natural environment. By using appropriate assumptions and professional judgment, effects of actions can be reasonably estimated with confidence. (These estimated effects are presented as the main part of this chapter.) While no estimate of effects for a given alternative is absolutely correct, the relative effects (compared to other alternatives) can be reliably estimated. There is sufficient information with regard to environmental effects to provide a clear basis for choice among options.

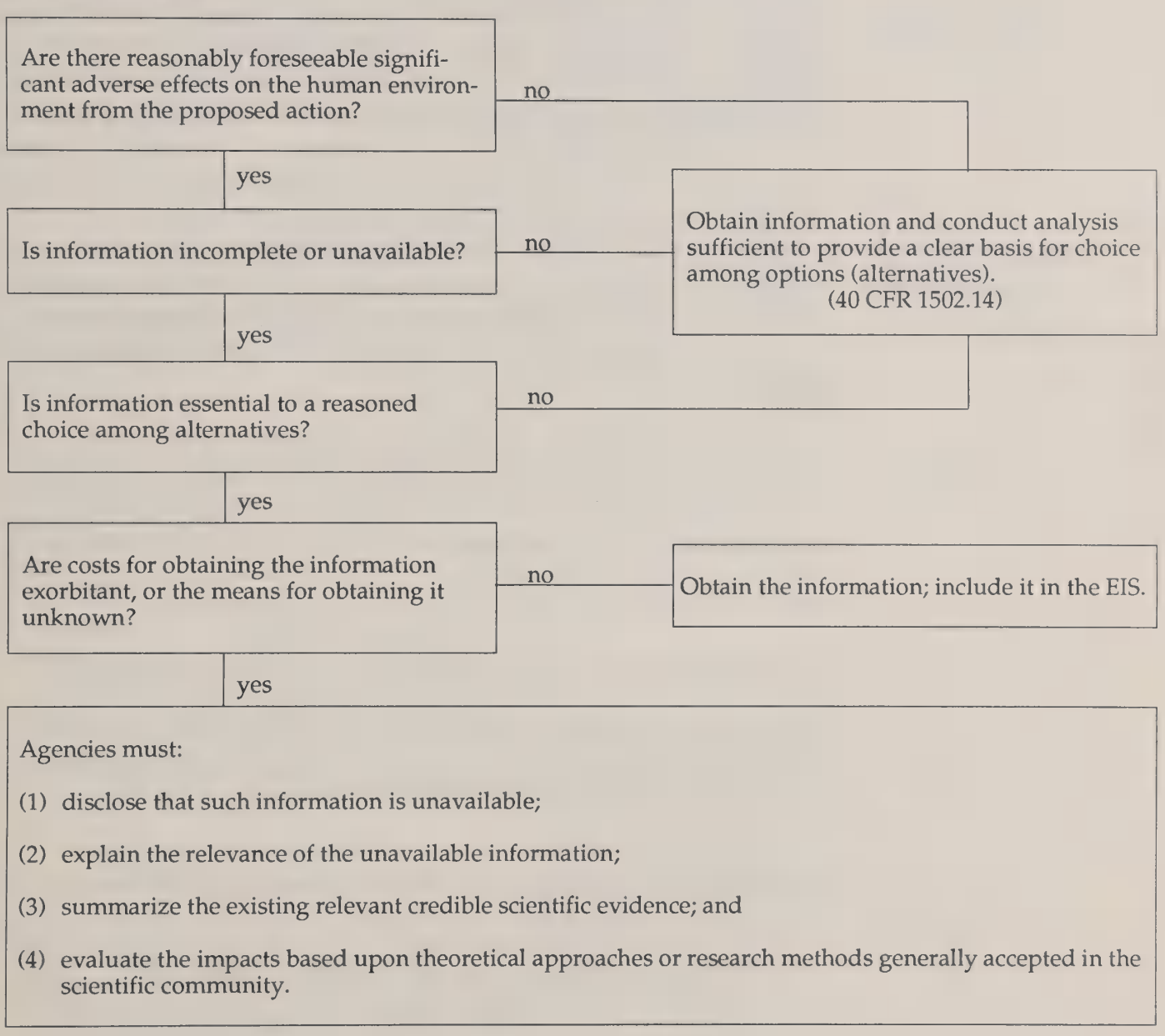
Human Health Impacts

Human health concerns related to managing competing and unwanted vegetation have been the subject of controversy for many years. Safety of herbicides is the most controversial aspect of this issue. The health effects of smoke from burning has also emerged as an issue. The controversy in large part stems from the very fact that information is incomplete or unavailable. As a result, there are strongly differing (though still scientifically credible) opinions as to the human health effects of herbicides and of smoke.

Figure IV-1

Incomplete Or Unavailable Information

(40 CFR 1502.22)



Therefore, the more rigorous standards identified in the Code of Federal Regulations—40 CFR 1502.22—are applicable to analyses associated with human health effects of herbicides and of smoke. Rigorous analyses on human health are contained in Appendix D, Human Health Risk Assessment, which contains quantitative estimates of risk; Appendix H, Human Health Effects, which explores the qualitative aspects of risk; and a special appendix, Characterization and Management of Risk, which provides a synthesis of both qualitative and quantitative aspects.

Incomplete or Unavailable Information

A detailed and systematic determination of the quality of available information for the human health effects of herbicides is identified in the section on Human Health Effects in this chapter. Information that is incomplete or unavailable for human health effects of herbicides is summarized in Appendix H.

The costs of obtaining more precise and conclusive data were estimated and were found to be exorbitant. While there is incomplete and unavailable information, much information about the human health effects of herbicides does exist. A large portion of the information that does exist was developed by private companies in support of the Environmental Protection Agency's registration process.

Much information is incomplete or unavailable for the human health effects of smoke associated with management of vegetation, slash burning, or wildfire. The state-of-the-art for evaluating air toxics is relatively primitive, compared to the toxicology of pesticides. Information is incomplete or unavailable in the following areas:

- characterization of human exposures to smoke, including composition of smoke, concentration of its components, duration of exposures, and populations exposed;
- the toxicology of many of the constituents of smoke; and
- methodologies generally accepted in the scientific community for characterizing human health risks from smoke from Forest-prescribed burns and wildfires.

Because the state-of-the-art is new and relatively undeveloped, the means to obtain the necessary information are unknown. Costs of advancing the state of the art sufficiently to allow characterization of human health risk due to smoke are inestimably large and therefore, are exorbitant. The direct costs of delaying action until the information is obtained would be unacceptably large. Delay would also have

undesirable impacts related to unemployment, travel accidents, and increased wildfire risk, as characterized by the effects of Alternative C.

Statement of Relevance

The relative human health effects of herbicides and smoke can be compared among the alternatives. Comparisons are made in this EIS for accidents from manual control of brush; accidents from prescribed burns; health effects from exposure to smoke; and health effects from exposure to herbicides (see the Human Health Effects section of this chapter and the comparison section of Chapter II). The comparisons are based on the number of acres treated by various means for each alternative. All alternatives are compared to an alternative that approximates a likely future. The uncertainty for which there is incomplete and unavailable information is for the actual human health risks from herbicides and smoke associated with the agency's programs.

Summary of Information

Information that is currently available is summarized in several places in this EIS:

Appendix H ..... Human Health Risk Assessment (Qualitative)

Appendix D
- Section 3 ..... Hazard Analysis
- Attachment A ..... Details of Mutagenicity and Carcinogenicity

Chapter IV ..... Human Health Effects

Special Appendix ..... Characterization and Management of Risk

Evaluation of Impacts

The human health effects of the alternatives are compared in Chapter II. The detailed human health effects of the alternatives are discussed in Chapter IV. In the course of evaluating potential human health effects, three kinds of information were used: historical studies, research studies, and quantitative predictions.

Historical information (such as accident rates) was used to estimate comparative effects of alternatives, using the alternative that most closely approximates the historical programs as a baseline.

Many research studies were used to determine what effects are currently known (see listings in Appendices D and H). A great number of research studies have been conducted by private companies in support of registration of herbicides by the Environmental Protection

Agency. Enough information is available that risk can be reasonably characterized for all herbicides being considered except two—diuron and fosamine. Quantitative estimates of risk are contained in Appendix D, which is a detailed quantitative human health risk assessment that considers four different scenarios: 1) routine-worst case; 2) routine-realistic; 3) accidental spills; and 4) accidental spraying. Estimates of human health effects which could occur for each herbicide being considered for use is shown in the tables in the Human Health section of this chapter.

Considerably less research information is available for the human health effects from smoke associated with the management of competing and unwanted vegetation. As noted above, in addition to not being able to characterize exposures and having very limited data on toxicology of all of the constituents of smoke, methodologies for characterizing human health risks from smoke associated with vegetation management have not been developed. Effects of smoke were evaluated using the limited information and estimates currently available.

With the exception of no action, the risks to humans associated with the management of vegetation is more closely correlated to the number of acres treated, rather than to what tool is used. All vegetation management activities pose some risk to human health: the more work done, the more risk incurred.

Consideration of risk can take two forms: risk assessment, and risk management. The process of risk assessment by government agencies was studied by the National Research Council Committee on the Institutional Means for Assessment of Risks to Public Health ("NRC Committee"). The Committee noted that:

> "Risk assessment is an analytic process that is firmly based on scientific considerations, but it also requires judgements to be made when the available information is incomplete. These judgements inevitably draw on both scientific and policy considerations." (NRC Committee, 1983, p.48.)

> "Risk management is the process of weighing policy alternatives and selecting the most appropriate regulatory action, integrating the results of risk assessment with engineering data and with social, economic, and political concerns to reach a decision." (NRC Committee, 1983, p. 3.)

This EIS assesses risk. It provides information for making strategic decisions about the management of risks by selecting one of the alternatives and develops guidelines for the management of risk for deriva-

tive vegetation management projects. One mitigating measure developed as part of this EIS is that all subsequent derivative vegetation projects will include the development of a Human Health Risk Management Plan to assure the consideration and protection of human health in all vegetation management projects (see Chapter II, Methods and Mitigating Measures).

Chapter 4
Environmental Consequences

- Geology
- Climate
- Soil Resources
- Fire
- Air
- Water Resources

Geology

Geology interacts either directly or indirectly with all other environmental factors. For example, serpentine exerts a major influence in controlling soil development, species composition, and growth rates. Soil moisture retention is indirectly related to the geologic material and how it weathers. However, the implementation of alternatives and the application of methods considered in this environmental impact statement are not expected to affect the geology.

Climate

Climate interacts with all other environmental components directly and indirectly. Vegetation management activities are not expected to have significant or cumulative effects on the climate of the Region. Although plants play a major role in the carbon dioxide/oxygen balance, the effects of any reduction in vegetation on the climate are thought to be insignificant.

Replacement vegetation in vigorous managed Pacific Northwest ecosystems will re-incorporate most, if not all of the carbon dioxide released during prescribed burning (unlike the cases of burning fossil fuels, or the "clearing and burning" of tropical forests). The smoke from prescribed burning does intercept and absorb or reflect an extremely small amount of incoming solar radiation, but it is not enough to measurably affect the Earth-atmosphere energy balance. On the other hand, vegetation that is burned does not decay. Decaying vegetation produces methane, which contributes to the "greenhouse" gas.

Local, site-specific microclimate changes will occur. The degree of change depends on the specific method used, and the intensity, frequency, and extent of its application.

Generally, chemical, biological, and manual methods have low impacts on the soil surface, compared to mechanical and thermal methods. Disruption of the soil surface can change the site's ability to transfer heat and water and result in an increase in temperature extremes. Burning blackens the surface and changes radiation input, but the effect is temporary (see the discussion on the effects on soils).

Soil Resources

Manual Methods

Site disturbance caused by manual methods of vegetation management (such as manual cutting of brush for rights-of-way clearing or conifer release; hand scalping for site preparation; hand pulling of weeds; and hand piling of slash) is usually negligible. The duff layer is usually not affected, or is only disturbed in a very small area. If large areas are cleared of duff and debris on steep slopes, there is a potential for accelerated erosion. However, the amount of vegetation removal by manual methods is usually not sufficient to cause substantial impacts on the soil resource.

Table IV-1

Acres (Thousands) Manually Treated Each Year

(Includes site preparation and release, fire management, range improvement, noxious weed control, and wildlife habitat improvement activities.)

Alternatives	A	B	C	D	E	F	G	H
East-side Forests	39.0	43.0	5.5	25.9	56.3	38.5	46.4	44.6
West-side Forests	47.3	21.6	7.0	25.5	26.7	29.6	27.2	24.9
Totals	86.3	64.6	12.5	51.4	83.0	68.1	73.6	69.5

Table IV-2

Miles (Thousands) Manually Treated Each Year

Alternatives	A	B	C	D	E	F	G	H
East-side Forests	3.9	4.0	2.0	2.3	3.6	3.5	3.5	3.9
West-side Forests	4.6	4.8	1.5	2.0	4.4	4.5	4.5	4.6
Totals	8.5	8.8	3.5	4.3	8.0	8.0	8.0	8.5

Mechanical Methods

The majority of acres treated by mechanical methods involve tractor piling slash (for site preparation or fuels treatment), or scarification (for site preparation). Mechanical brushing for roadside clearing is not included in Table IV-3 because equipment is operated from an established roadway, and thus has low potential for effects on the soil.

Table IV-3

Acres (Thousands) Mechanically Treated Each Year

Aternatives	A	B	C	D	E	F	G	H
East-side Forests	126.6	132.4	26.9	85.8	123.1	134.6	118.7	93.5
West-side Forests	40.8	28.6	8.9	18.4	34.5	58.8	27.9	26.4
Totals	167.4	161.0	35.8	104.2	157.6	193.4	146.6	119.9

Potential Direct and Indirect Impacts

Tractor piling of slash or scarification for site preparation can cause soil compaction, puddling of water, and surface erosion. Disturbing the duff layer and removing organic material can also lead to a reduction in site productivity. These adverse impacts can be prevented or minimized by proper use of equipment and care in timing of activities (see Chapter II, Mechanical Methods, Mitigation Measures).

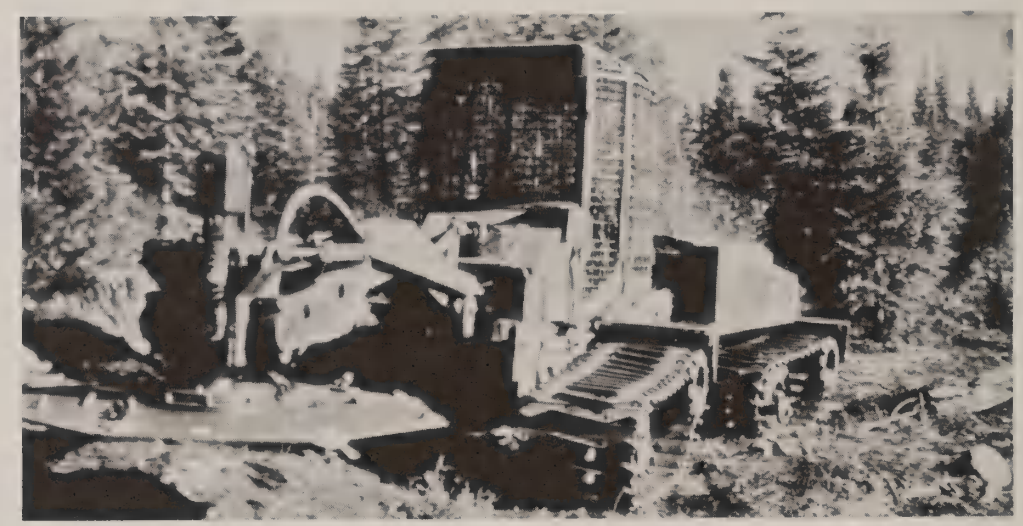
Discussion

Mechanical methods involve ground disturbance, and have the highest potential of any method of vegetation management for direct impacts on soils (Newton and Norgren,1977). Soil disturbance from scarification and construction of tractor trails causes compaction (Froehlich,1973). Compaction can lead to a decrease in rooting depth, which can result in reduced shoot or leader growth.

The long-term effects of compaction are unknown, but it may cause a reduction in soil productivity (Froehlich,1973) and inhibit extension of mycorrhizal fungal mycelia (Perry and Rose,1980). Mycorrhizal fungal mycelia are important for water and nutrient uptake in most plant species.

Detrimental compaction primarily occurs when soils are wet. It can be minimized by restricting operations to dry seasons or choosing other methods on critical soils.

Mechanical site disturbance may also remove some of the protective duff layer. In combination with compaction, this may increase the potential for surface erosion, especially on steeper slopes. Accelerated erosion removes the productive topsoil and leads to a loss in site productivity. Therefore, operation of wheeled or tracked equipment is limited to slopes under 35 percent, as specified in Forest Service Manual 2520 (see Chapter II, Mechanical Methods, Mitigation Measures).



Mechanical site disturbance has the highest potential of any vegetation management method for direct impacts on soils.

Yarding of unmerchantable material (YUM) involves removing residue that, left undisturbed, would be available to decompose and supply organic matter and nutrients to the soil. While site disturbance from this procedure is usually minimal, the removal of large volumes of organic matter from a site could affect nutrient cycling and long-term productivity.

Conclusion

There may be potential for long-term effects on soil productivity and nutrient cycling from removal of organic material (from yarding of unmerchantable material), disturbance of the duff layer, or compaction.

Adverse effects on the soil caused by mechanical methods of vegetation management can be minimized by consideration of site-specific conditions such as slope, soil moisture content, the duff layer, and soil compaction as described in the mitigation measures for mechanical methods discussed in Chapter II.

Selection and operation of equipment is also important in preventing adverse impacts to the soil resource. Mitigation measures for mechanical methods are the same for all alternatives.

Alternatives A, B, E, F, and G involve similar levels of mechanical methods of vegetation management. Thus, they have similar impacts on soil resources.

The next two paragraphs describe the relative change in number of acres receiving mechanical treatment, compared to Alternative B, which also functions as a reference for describing changes produced by the alternatives.

Alternative H provides for mechanical treatment of 74 percent of the acres that would be treated under Alternative B. This means a corresponding reduction in potential impacts on the soil for Alternative H.

Alternative D provides for mechanical treatment of 64 percent of the acres that would be treated under Alternative B. Alternative C, the "no action" option, provides for mechanical treatment of 20 percent of the acres thus treated under Alternative B.

Prescribed Burning

Prescribed burning includes broadcast burning, burning of residue in piles, and underburning.

Potential Direct and Indirect Effects

Burning can adversely affect the duff layer, leading to surface erosion and reduced site productivity. An extremely severe burn may also alter the soil microbial community. Accelerated mass wasting (soil and rock slides or flows) on steep slopes after shrubs are burned may also be an indirect effect.

Table IV-4

Acres (Thousands) Thermally Treated Each Year

(Includes site preparation and release, precommercial thinning, natural and activity fuels treatment, and wildlife habitat improvement activities.)

Aternatives	A	B	C	D	E	F	G	H
East-side Forests	157.0	151.5	0	91.4	151.1	119.9	152.4	147.4
West-side Forests	60.8	50.5	0	34.4	42.7	55.9	62.6	54.6
Totals	217.8	202.0	0	125.8	193.8	175.8	215.0	202.0

Discussion

Loss of organic matter may be the most important fire effect. Some of the nutrient capital held in the logging debris, litter, duff, and soil is volatilized during burning and is leached from the ashes (Kraemer and Hermann,1979).

Depending on the temperatures produced, 30 to 90 percent of the nitrogen in the organic materials may be lost from the site immediately. Persistent, deep burning slash fires will cause additional losses

of nutrients during the first few years after burning (Sidle,1980). A fire which heats the soil to temperatures above 100 degrees Centigrade will temporarily alter the microbial community, and can also trigger a pulse of surface erosion. The alteration of the microbial community by fire may directly kill soil organisms in the litter layer and upper soil layers. It may also indirectly affect soil microorganisms by altering the environment so one type of organism is favored over another. Burning may also affect the rate of nutrient cycling (Perry et al.,1985).

The amount of surface erosion is generally proportional to the severity of the burn as measured by the amount of exposed inorganic soil (consumption of the forest floor). Burn severity is controlled by fuel loading, fuel moisture content, and soil moisture content (Bennett,1982). Relatively unproductive sites, such as those on steep slopes (greater than 60 percent), with shallow organic layers or high erosion potential, are the most vulnerable to damage from excessively hot fires (Perry et al.,1985).

A severe burn on a dry site may cause a water-repellent layer to form beneath the soil surface. This layer blocks the infiltration of water into the soil (Sidle,1980), and can cause accelerated erosion. However, experience in the Pacific Northwest Region has shown this condition to be an infrequent effect of burning.

The effects of burning on slope erosion will generally persist for only one season, but may last longer on harsh sites where vegetation is slow to recolonize.

Indirect effects of burning caused by removal of the litter layer include reduced infiltration and water storage capacity, with consequent increased runoff and erosion potential. Once organic matter is consumed, the stability of soil aggregates is lost and dry ravel occurs (Everest and Harr,1982). Dry ravel is the crumbling and downslope movement of the surface layer of soil. (See Everest and Harr,1982). Single-grained soils (such as those derived from granitic material or volcanic ash) are most susceptible to surface erosion following burning.

Following burning, increased mass wasting (movement of soil and rock due to gravity, including rock slides, debris avalanches, and earth flows) may occur on sites steeper than 60 percent that are prone to mass failure. Loss of root strength and reduction in evapotranspiration due to loss of residual vegetation after burning can result in such instability. However, timber harvest and road construction are likely to be more important activities in affecting the occurrence of mass failures on such sites.

Machine piling of logging residues or crushing of vegetation is sometimes used to concentrate fuels prior to burning. This practice is restricted to slopes that are less than 35 percent.

There is a danger of causing heavy damage to the soil beneath burn piles due to the high soil temperatures resulting from fire which burns in one place for an extended period. However, the damaged area is seldom greater than a small percent of the total area. According to Forest Service Manual 2520, a minimum of 80 percent of an activity area must be left in a condition of acceptable productivity (see Chapter II, Mechanical Methods, Mitigation Measures).

Broadcast burns for hazard reduction and site preparation have the highest potential for damage on sites with single-grained soils and thin duff layers. Prescribed burning conducted for range and wildlife habitat improvement are generally of lower severity due to smaller fuels and the resulting rapid passage of the fire.

To prevent complete destruction of the litter layer and minimize the amount of organic material lost during the burn, several factors are considered in the timing of a burn. These include fuel moisture, soil moisture, and fuel loading. (See the Chapter II section on mitigation measures for prescribed burning.)

Conclusion

The potential for detrimental effects on soils due to burning exists on steep slopes; southern exposures (when a large proportion of the organic litter and duff layers are removed); single-grained (granitic) soils; and from excessively hot burns. Actual effects are highly dependent on site conditions, which vary tremendously throughout the Region.

A site-specific, project-level analysis is required by all alternatives in this EIS to assure that prescribed burning is done only under conditions which prevent removal of more of the organic layer than is absolutely necessary.

Alternatives C, D, and F show a substantial reduction in acres treated with prescribed fire. Alternative H provides for thermal treatment of 86 percent of the acres that would be treated under Alternative B. (For related information, see the section on fire in this chapter.)

Biological, Cultural, and Grazing Methods

Grazing of sheep and cattle is a vegetation management technique used in the Pacific Northwest Region. Other techniques, such as release of insects and pathogens which selectively feed on or damage target weeds, are used in limited areas in cooperation with the USDA Agricultural Research Service and various state agencies.

Table IV-5

Acres (Thousands) Grazed Annually

(Site preparation and release activities.)

Aternatives	A	B	C	D	E	F	G	H
East-side Forests	11.4	0.8	0	14.1	2.3	5.2	2.8	1.6
West-side Forests	3.4	3.5	0	4.6	3.6	3.1	4.1	2.4
Totals	14.8	4.3	0	18.7	5.9	8.3	6.9	4.0

Grazing of sheep and cattle for site preparation and release occurs primarily on East-side Forests in a limited number of plantations. Prolonged or forced grazing by cattle has been primarily an East-side technique, while use of sheep has been concentrated in the Coastal area.

Grazing for vegetation management is a very small program compared to the range program (where National Forest lands are grazed for livestock production). This analysis is not intended to consider effects of the entire range program.

The main effects on soils due to grazing include compaction of wet soils from trampling and surface erosion on steep hillsides due to loss of plant cover from overgrazing. However, these effects usually do not occur when grazing is used specifically for the vegetation management program.

When grazing is used for vegetation management in plantations, close control of livestock is required to prevent damage to the desired vegetation. This constant supervision of the livestock, in addition to fencing and upslope water developments, is also used to keep livestock from concentrating in wet areas and overgrazing to the point that desired vegetation is damaged.

There is low potential for soil and water damage, due to the limited number of acres involved (a maximum of 18,700 acres, or less than 0.1 percent of the Region, in any alternative), and also due to the close control of livestock when grazing is used for vegetation management.

Other cultural methods of vegetation management (such as seeding roadsides with desired species) can have beneficial effects on soils. The protective cover of vegetation will prevent soil erosion and add organic material to the soil.

Herbicides

Herbicides may be applied aerially, by truck-mounted or backpack sprayers, or by stem injection. Tables IV-6 and IV-7 display the acreage likely to be treated each year in different activity areas under the alternatives.

Table IV-6

Acres (Thousands) Treated With Herbicides Each Year

(Includes silviculture, range improvement and noxious weed control.)

Aternatives	A	B	C	D	E	F	G	H
East-side Forests	0	15.7	0	11.0	16.3	23.9	27.1	6.8
West-side Forests	0	34.3	0	7.1	21.4	31.1	37.3	29.7
Totals	0	50.0	0	18.1	37.7	55.0	64.4	36.5

Table IV-7

Miles (Thousands) Treated With Herbicides for Road Maintenance Each Year
(Forest Service applications)

Aternatives	A	B	C	D	E	F	G	H
East-side Forests	0	1.4	0	0.9	1.3	1.3	1.7	0.9
West-side Forests	0	5.1	0	4.9	5.5	4.8	6.4	4.9
Totals	0	6.5	0	5.8	6.8	6.1	8.1	5.8

Potential Direct and Indirect Effects

The persistence of herbicides in the soil depends on chemical properties, climatic factors, soil properties, and initial rate of application.

Discussion

Though much of the herbicide applied falls on foliage, the soil is also a major receptor for herbicides, whether applied aerially or by truck-mounted and backpack units.

Soil and the forest floor comprise an active biological system that decomposes herbicides. Herbicide degradation is usually biological (U.S. Environmental Protection Agency,1980). Warmer temperatures during periods of adequate moisture generally favor decomposition by microbes.

Persistence is the predominant factor affecting a herbicide's presence in the environment. Climatic factors and soil properties of the particular site, and the characteristics of the particular chemical influence the actual length of time an herbicide remains in the soil.

Soils high in clay and organic matter can prevent movement of herbicides (due to leaching) by providing sites for adsorption (adhesion onto the surface of a particle) and absorption (incorporation into a particle) of chemicals. Soils with low pH also tend to increase adsorption. Areas with abundant rainfall increase the chance of mobilization of herbicides by leaching or runoff.

Table IV-9 at the end of this section provides a relative comparison of the 16 herbicides approved for forest use. The two most commonly used herbicides (used on 60 percent of the acres treated) are 2,4-D and glyphosate; each has a fairly short half-life. (The half-life is the average time it takes for 50 percent of the chemical to degrade by various mechanisms.)

In warm, moist loam soils, 2,4-D can be expected to decompose within 2 to 3 weeks (Lorz, 1979). Studies in the Coast Range (Perry and Rose,1980) report a half-life for glyphosate of 29 days in litter-covered soil, and 40 days in bare soil.

Application of triclopyr, atrazine, and picloram constitute another 20 percent of the acres treated. The half-life of triclopyr is strongly dependent on soil conditions and climate. Its half-life may be up to 46 days (USDA-Forest Service,1984b). Norris and others (1987) measured a 50 percent loss of triclopyr in 3.7 days and a 90 percent loss in 40 days in western Oregon.

Most herbicides seem to persist longer in cold, arid climates. The half-life for atrazine has been reported to vary from three to twelve months, while picloram has been reported to have a half-life anywhere from one month to four years in arid conditions (USDA-Forest Service,1984b).

Many soil microorganisms can metabolize herbicides, and are often reported to be responsible for herbicide decomposition (Norris and Moore,1981). However, there may be adverse effects on micro-organisms. Experimental tests yield widely varying results, from toxic effects to stimulation of certain populations.

Use of herbicides does not involve removal of vegetation from the site, but instead results in a pulse of dead organic matter on the site. Due to subsequent decomposition and release of nutrients, the impact on the nutrient pool may be negligible if soil micro-organisms are not affected.

Under Alternatives B and G, approximately 500 acres would receive what is commonly called "brown and burn" treatment. This practice involves aerial spraying of vegetation with herbicides in order to desiccate it. Five to seven months later, the site is broadcast burned. "Brown and burn" treatments are limited to the steep, brushy, hardwood-covered terrain found in the Oregon Coast Range. The herbicides used are typically 2,4-D, glyphosate and triclopyr. Under Alternative H, vegetation that has been treated with herbicides within the same year will not be burned. Utilization of management activity-generated residues is preferable to burning.

Since the half-life for each of these herbicides is well under two months (see Table IV-10), most of either chemical will be degraded prior to broadcast burning. Degradation would occur primarily from microbial action, which should occur rapidly in the warm, moist conditions typically found on these sites. Therefore, effects on the soil would be the same as for the individual effects of broadcast burning and application of herbicides.

Conclusion

Persistence of herbicides in soil is highly variable in the natural environment. Potential adverse impacts on soils from use of herbicides are primarily related to possible toxic effects on soil organisms or changes in species composition of these organisms. Conclusive data on this topic is lacking. Use of herbicides does not directly impact the duff layer of soil structure.

Alternatives A and C, which prohibit use of herbicides, would pose no risk of adverse impacts on the soil from the use of chemicals. Alternative D would result in the smallest acreage chemically treated, followed (in increasing order for number of acres treated) by Alternatives H, E, B, F, and G.

Cumulative and Synergistic Effects

Cumulative impacts are "the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions" (CEQ Reg. 40 CFR 1508.7). A cumulative impact occurs if effects do not return to pretreatment levels prior to the next action.

For example, if a site is compacted by tractor piling of slash, but recovers (through freeze and thaw, or the action of roots and burrowing animals) prior to the next entry, then that is an individual impact, not a cumulative impact. However, if the site remains compacted and another entry occurs, the effect accumulates at each entry.

Due to the synergistic nature of these interrelated effects, the cumulative effect may be more than the sum of the individual effects.

Potential Cumulative Effects

Potential cumulative effects on soils (due to the effects of past or future management on a site combined with vegetation management) include decreased site productivity, increased mass wasting, and build up of chemicals in the soil. Table IV-8 displays the total acres treated annually for vegetation management by method, with possible adverse impacts on soil.

Table IV-8

Acres (Thousands) Treated Each Year Using Methods With Possible Impacts on the Soil Resource

	A	B	C	D	E	F	G	H
Herbicides[1]	0	59.8	0	26.8	47.9	64.1	76.5	42.6
Mechanical[2]	167.4	161.0	35.8	104.2	157.6	193.4	146.6	160.1
Biological	14.8	4.3	0	18.7	5.9	8.3	6.9	7.4
Prescribed Fire	217.8	209.9	0	125.8	193.8	175.8	215.0	202.0
Totals	400.0	435.0	35.8	275.5	405.2	441.6	444.0	412.1

[1] Includes rights-of-way, trail, and roadside miles, converted to acres.

[2] Does not include roadside and rights-of-way brushing.

Discussion

Disturbance of the duff layer and loss of woody material by mechanical or thermal methods after timber harvest may contribute to reduced long-term site productivity. Removal of shrubs by mechanical, thermal, or chemical methods following timber harvest may also

affect nutrient cycling, but vegetation management usually does not have severe enough effects to cause a significant impact.

Removal of nitrogen-fixing plants (such as red alder and ceanothus) may have a substantial impact on long-term soil productivity. Far more nitrogen is removed in harvest and site preparation than is added by natural sources other than alder (Perry et al. 1985). Perry also states that red alder may suppress the pathogen *Phellinus weirii.*

Some impacts on soils occur from removal of vegetation, regardless of the method employed. Removal of vegetation cover can cause 1) an increase in soil moisture due to reduction of evapotranspiration; 2) changes in snow accumulation patterns; or 3) loss in root strength. These can lead to increased mass wasting on steep slopes.

Trees are the dominant forces in soil stability, but shrubs may play a role when trees are removed. However, vegetation management results in only a temporary setback of shrubs, not elimination of them. Other activities, such as construction of roads and removal of timber on steep slopes, have the primary impacts on slope stability (EPA, 1980). The additional increase in instability due to removal of competing vegetation is negligible in comparison.

Repeated applications of herbicides may occur for road maintenance, site preparation and release, genetic tree improvement, noxious weed control, range improvement, facilities maintenance, and rights-of way maintenance. A buildup of herbicide residues in the soil is possible if repeated applications occur before sufficient time passes for the previous application to break down. However, the time interval between applications of herbicides on National Forest lands usually exceeds the time required for decomposition.

The acreage involved in repeated application is small. Treatments occasionally occur annually, but more often every two to seven years. Annual treatments are usually on a spot basis. Application of herbicides for site preparation and release may occur within two to eight years on a site, but repeated applications within a year would occur on less than 100 acres in the Region. Over the course of a timber rotation (80 to 120 years), more than three applications to the same area are rare.

The persistence of the specific herbicide used and its susceptibility to water transport, local environmental conditions, and the rate and frequency of application determine the potential for buildup of residues in the soil.

Table IV–9

Comparison of Herbicides

CHEMICAL	*Amitrol*	*Asulam*	*Atrazine*	*Bromacil*	*2,4-D & 2,4,DP*	*Dalapon*	*Dicamba*
Persistence	short–med. (1,2,6)	short (2,6)	long (2)	med.–long (2)	short (1,3,5)	short (2,6)	med. (1,6)
Adsorption to Soil Particles	strong, but reversible (1,2)	negligible (2)	readily, but not strong	low (2)	not strong (2,5)	none (2)	none (2)
Solubility in Water	high (2)	**	low (1)	high (2)	high-acid, salt, low-ester form (5)	high (2)	high (2)
Mobility	moderate	moderate	moderate	high	moderate	moderate	high
Acute Toxicity	low (9)	low (2)	high (2)	low (7)	high-ester low-salt (9)	low (9)	low (9)

(Note: numbers in parentheses refer to references at the end of this table.)

PERSISTENCE—short = half-life less than 1 month; med. = half-life 1–6 months; long = half-life greater than 6 months; varies with climate and formulation

ADSORPTION—adhesion of the chemical onto the surface of soil particles.

SOLUBILITY—low = less than 500 milligrams per liter (mg/L); high = greater than 500 mg/L; will vary with environmental conditions and formulation.

MOBILITY—an evaluation of the chemical's susceptibility to transport by water, based primarily on persistence, with consideration given to strength of adsorption to soil particles and water solubility. Environmental conditions, timing of application in relation to rainfall, and distance to surface or groundwater will affect actual concentrations reaching a water source.

RELATIVE ACUTE TOXICITY TO FISH—the lowest 96-hour LC_{50} value (concentration that killed 50 percent of the test organisms within a 96-hour period) found in the literature for a fish species, where low = greater than 10 parts per million (ppm); mod. = 1–10 ppm; high = less than 1 ppm (based on classification by Clark et al. 1970).

Toxicity is influenced by environmental conditions such as water quality; life stage of the fish species tested; and conditions of the test, such as static or flow through. Other aquatic organisms may be more or less susceptible to a chemical than the fish species reported, and sublethal effects may occur at much lower concentrations. The purpose of this column is to provide a relative comparison among the chemicals.

Diuron	*Fosamine*	*Glyphosate*	*Hexazinone*	*Picloram*	*Simazine*	*Tebuthiuron*	*Triclopyr*
med. (2)	short (2,3,5)	short–med. (2,4)	med.–long (3)	long (2,6)	long (2,6)	long	mod. (2,6)
readily to clays and organic matter (2)	strong (2)	strong (2)	low (10)	low, to organic matter (2,5)	readily (2,8)	to organic matter and clays (2)	not strong (2)
**	high (3,5)	high (3,5)	high (3)	high (2,5)	low (2)	low (2)	**
moderate	low	low to moderate	high	high	mod.	mod. to high	mod. to high
high (10)	low (9)	mod. (2) Roundup, low	low (9)	mod. (9)	high (2)	high (2)	low (9)

** Data reviewed was insufficient to evaluate this characteristic.

(1) Lorz, Harold W. et al. 1979. *Effects of Selected Herbicides on Smolting of Coho Salmon,* EPA-600/3-79-071.

(2) USDA-FS, 1984-6. *Pesticide Background Statements Vol. Herbicides,* Agric. Handbook No. 633 and Supplements.

(3) Norris, L.A. 1982. *The Behavior of Herbicides in the Forest Environment and Risk Assessment. Proc.* John S. Wright For. Conf., IN.

(4) Perry, D.A., and Rose, S.L. 1980. *Productivity of Forest Lands as Affected by Site Preparation.* Presented at the CA Conf. on Forest Tree Nutrition and Soil Fertility, May 19-20. Redding, CA.

(5) Norris, L.A. et al. 1983. *Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America: 9. Forest Chemicals.* General Technical Report PNW-149.

(6) Newton, M., and Knight, F.B. 1981. *Handbook of Weed and Insect Control Chemicals for Forest Resource Managers,* Timber Press.

(7) *Science Chapter: Bromacil, Ecological Effects, 1982.* Unpublished EPA document.

(8) *Science Chapter: Simazine, Environmental Fate and Exposure, 1983.* Unpublished EPA document.

(9) Mayer, F.L., Jr., and Ellersieck, M.R. 1986. *Manual and Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals.* USDI Fish and Wildlife Service Resource Publication 160. Washington, D.C.

(10) *Registration Standards for Hexazinone, Environmental Fate.* Feb., 1982. Unpublished EPA document.

For 80 percent of the acreage treated, the herbicides used (2,4-D, glyphosate, triclopyr, picloram, and atrazine) persist less than one year under conditions typical of the Region. For limited acreages involved in rights-of-way, roadsides, and rangeland treatments (where annual treatments may occur repeatedly) there may be a potential for buildup of herbicides.

Potential Synergistic Effects

Synergistic effects of herbicides are those that occur because of application of more than one herbicide, where the combined effect of the chemicals is greater than the sum of the effects of each agent alone.

The effects of the many possible combinations of herbicides have not been studied. The majority of vegetation management projects involve use of a single herbicide. The herbicide formulations used are combinations approved by the EPA. Since the choice of herbicide is determined by site characteristics and vegetation present, it is unlikely that a site would be sprayed with many different herbicide formulations for different purposes.

Conclusion

Project-level analyses will consider the potential cumulative impacts on soils in all alternatives. Vegetation management activities are usually part of a larger overall project. Thus, the effects of managing competing and unwanted vegetation will be analyzed along with the effects of the other management activities.

All alternatives meet agency direction for protection of soil resources in existing and projected Forest land management planning documents and Forest Service Manuals. The alternatives will also meet or exceed the requirements for protection of soil resources found in Washington, Oregon, and California Forest Practices Acts.

Changes in soil productivity or erosion will have effects on vegetation, water quality, channel stability, and fisheries resources. See the discussions on water resources, forest and range ecosystems, and fisheries resources in this chapter.

Application of herbicides may occur every other year on 2,200 acres of seed orchards and evaluation plantations in the Region. For noxious weed control and range improvement projects, a maximum of 6,800 acres (on East-side Forests) could receive annual applications for 2 to 4 years. Other areas of chemical re-application include roadside and powerline rights-of-way.

Fire

As a result of public comments, this section has been completely rewritten. Reviewers made two very important points about our analysis. Both are about reducing forest fire hazard through the vegetation management practice of prescribed burning.



Fire has always been a part of the natural ecosystem and an important factor in establishing the character of the affected site.

First, reviewers correctly pointed out that only Alternative C significantly restricts prescribed burning of fuels resulting from management activities (also called "activity fuels"), and that we should not have projected differences in wildfire losses among the alternatives. Therefore that material has been removed from this final EIS. Refer to Appendix I for detailed discussions of these and other comments.

The second point reviewers made is that burning the large heavy slash left over from logging activity does not always reduce fire hazard. Public and private forest land managers have long believed that slash burning does reduce fire hazard, and though it is expensive, it is a common practice. Only in recent years has it been shown that slash burning is not always an effective way to reduce fire hazard. This section of the EIS now describes the use of prescribed burning to reduce fire hazard.

Vegetation management can affect the occurrence of fire in a forest environment. The primary effect comes from using prescribed burning to reduce forest fuels as a fire hazard. Fuel hazard management reduces the risk and severity of wildfires that may occur on treated areas.

The alternative vegetation management programs could change fuel treatment practices. Those changes could in turn affect the occurrence and severity of wildfires. However, there is not a definitive means of assessing these potential changes.

For most of this century, National Forests have been managed under a policy of fire exclusion. This has allowed forest vegetation and its debris to accumulate (Wilson and Dell, 1971). This probably is not a problem in the moist Cascade and coastal forests of the Pacific Northwest. However, it could present Forests in drier zones with a high fire hazard.

The Pacific Northwest has another source of high fire hazard: the tons of debris and slash that accumulate from intensive forest management activities. Timber is harvested on more than 500,000 acres of all ownerships each year in Western Oregon and Washington. This results in more than 25 million tons of activity fuels.

Forest fires usually start in fine fuels (less than 1/4-inch diameter). Removing twigs and small branches (less than one inch diameter) from the forest floor eliminates the fire hazard. Prescribed fires can be designed to consume these fine fuels, while leaving the larger materials unburned (Sandberg, 1986). This is a very effective way to reduce fire hazard, and is often the least expensive. It is the preferred method for reducing natural fuel hazard.

Burning on some sites may result in a continuous cover of grasses and forbs. This can make successful ignitions more likely and the potential rate of fire growth greater, according to a joint USDA Forest Service (Pacific Southwest Region) and California Department of Forestry report (1987).

In western Oregon and Washington, managers of private forests do attempt to reduce accumulation of debris from management activities. Generally, their objective is to meet legal requirements and to reduce liability, rather than for actual hazard reduction. There are also some silvicultural benefits.

In eastern Oregon and Washington on the other hand, forests become drier during spring and summer, and lightning poses a frequent risk. In this case, reducing debris and slash from management activities may effectively reduce fire hazard, and a program of blanket fuel reduction might be justified.

Using prescribed fire to reduce fire hazard from activity-generated debris can have the opposite result. From 1974 through 1984, escaped

slash fires accounted for 7.5 percent of wildfires, and for 27 percent of the acres burned in Pacific Northwest National Forests. Escaped slash fires averaged 34 acres in size, while human-caused fires average only 10 acres. Agee (1988) states that since widespread slash burning began in the early 1900s, escaped slash fires in western Oregon and Washington have accounted for 25 to 30 percent of the acres burned by wildfires.

For reducing wildfire size and severity, there is certainly a major role for selective application of fuel reduction, fuel breaks, and other fuel hazard management strategies. The most obvious use is to isolate homes and comparable improvements adjacent to or within wildlands. Seed orchards, plantations, and intensively managed timber stands are examples of high value resources where fuel management may be justified.

However, the effectiveness and economic viability of "area-wide" fuel hazard reduction for most wildland situations deserves careful assessment (Saveland,1987; Wood,1978, 1979, 1982).

Applications of prescribed fire to reduce fuel hazard in the Southeast does appear to be cost effective because the costs of treatment (prescribed burning) are low; the resource values are high; and the risk of wildfire is very high (USDA Forest Service,1987e, a publication of the Southeastern Region of the Forest Service).

Historically, however, fuel hazard reduction programs have been justified without proper consideration of values protected, wildfire risk, and the risk posed by escaped prescribed fires. With the exception of Marcus (1981), none of the studies cited herein included escaped prescribed fires as a cost. Saveland (1987) states: "There is an opportunity for large financial gains in prescribed burning of natural fuels in critical areas. Further research is needed to determine the effect of prescribed burning on the magnitude of change of the probability of large, severe fires."

Air Quality

All of the vegetation management methods considered in this EIS may temporarily affect local air quality, but prescribed burning has the potential to significantly degrade air quality over large areas for extended periods. For that reason, the focus of this section is on prescribed burning.

Criteria

The criteria used in assessing the effects of prescribed burning on air quality under the eight alternatives are:

- attainment of the Ambient Air Quality Standard (NAAQS) for fine particulates
- protection of Class I area visibility; and
- compliance with state air quality and visibility enhancement strategies.

Westside Baseline Information

Previously, Sandberg et al. (1985) compiled inventories of total suspended particulates (TSP) from prescribed burning in western Oregon and western Washington (see Air, Chapter III). The periods inventoried were: 1) 1976 through 1979 and 2) 1984.

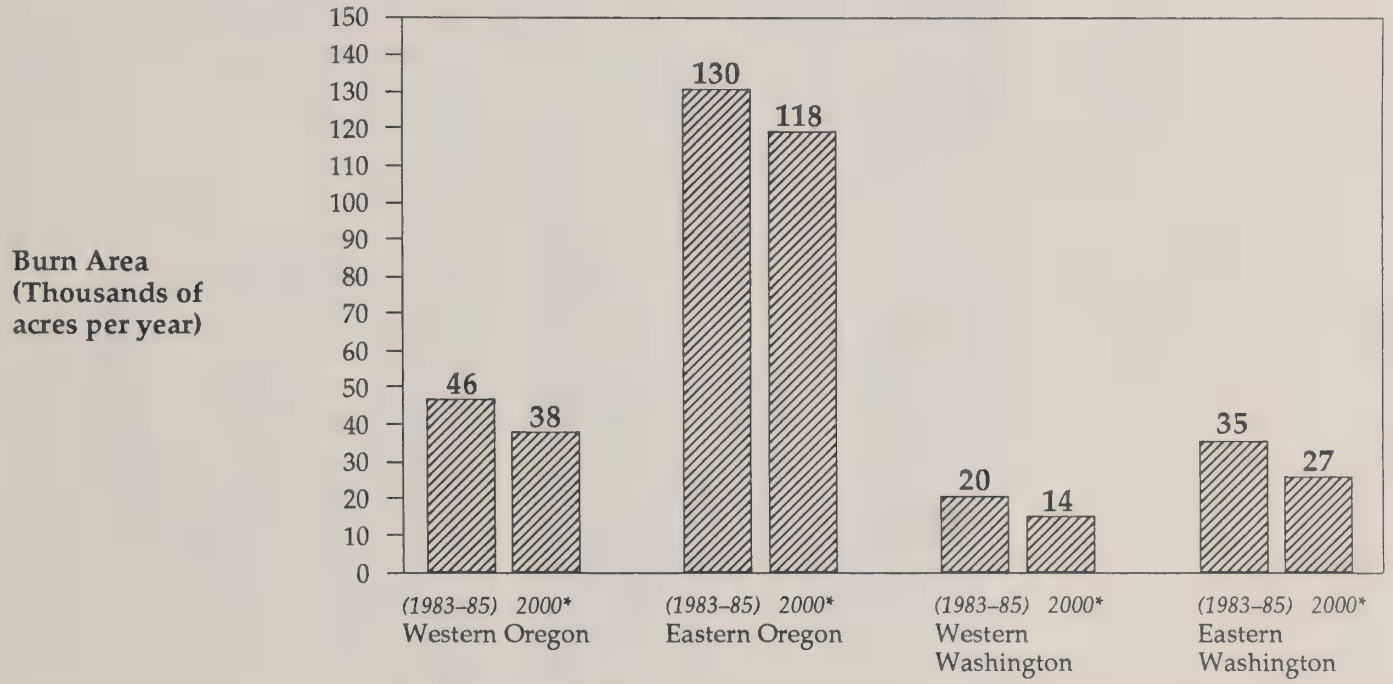
East-side Baseline Information

The same kinds of baseline average annual emissions information could not be developed for eastern Oregon and Washington National Forests because burning in those forests is not regulated by the Smoke Management Plans of either state. Hence, the 1976-1979 data on acres treated, burning technique, fuel loadings, and fuel moisture required by the model were not available for the emissions analysis.

For that reason, the 1983-1985 burning seasons were designated as the alternative annual emissions "baseline" for the analysis. Further, the region was divided into four subregions: western Oregon, eastern Oregon, western Washington and eastern Washington.

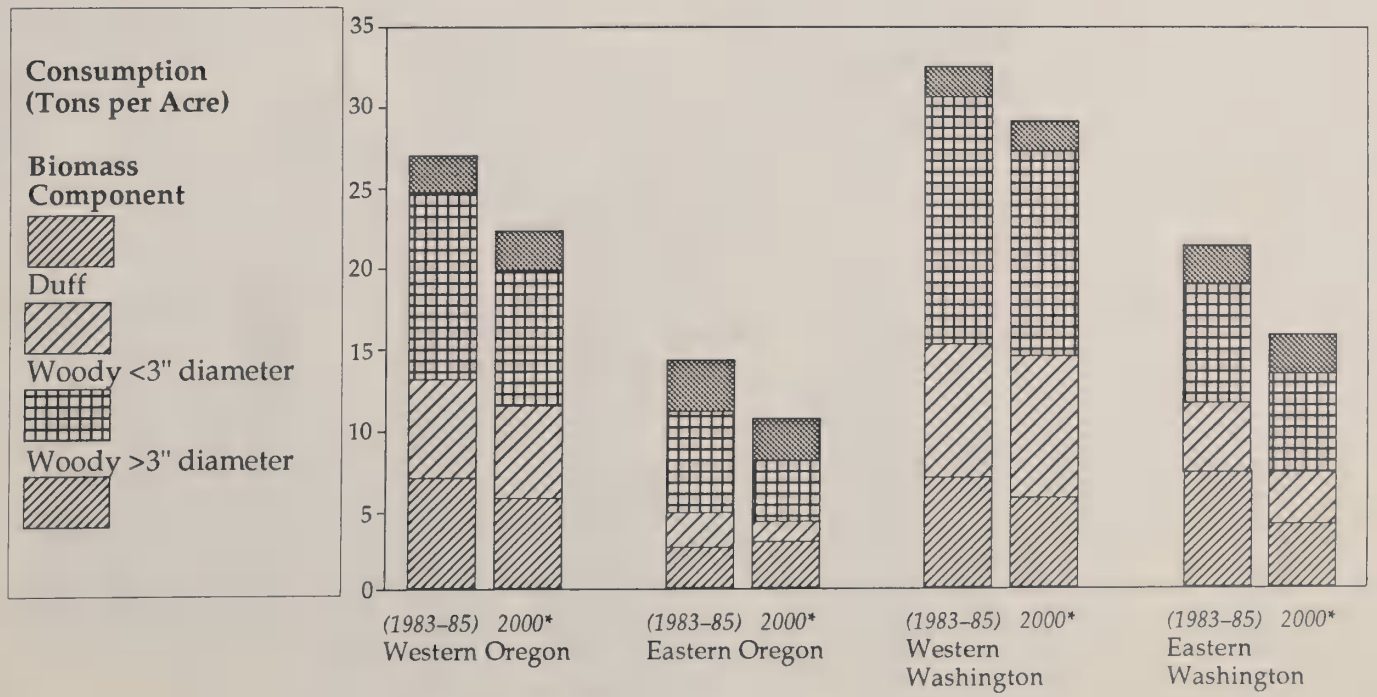
The analysis utilized 1986 prescribed burning data and projections for the alternatives that were compiled by National Forest fire-use specialists and fire planners. Those data were processed using a modified version of the emissions model developed by the Seattle Forest Sciences Laboratory Forest Fire and Atmospheric Sciences Research Team for the Westside inventories.

Figure IV–2
Area Prescribed Burned by Subregion



* These acreage figures are the **maximum** that will be prescribed burned under **any** of the alternatives.

Figure IV–3
Biomass Consumed by Prescribed Fire per Acre by Subregion



* For all alternatives; does not vary by alternative.

Figure IV–4

Fine Particulate (PM 2.5) Emissions by EIS Alternative Western Oregon

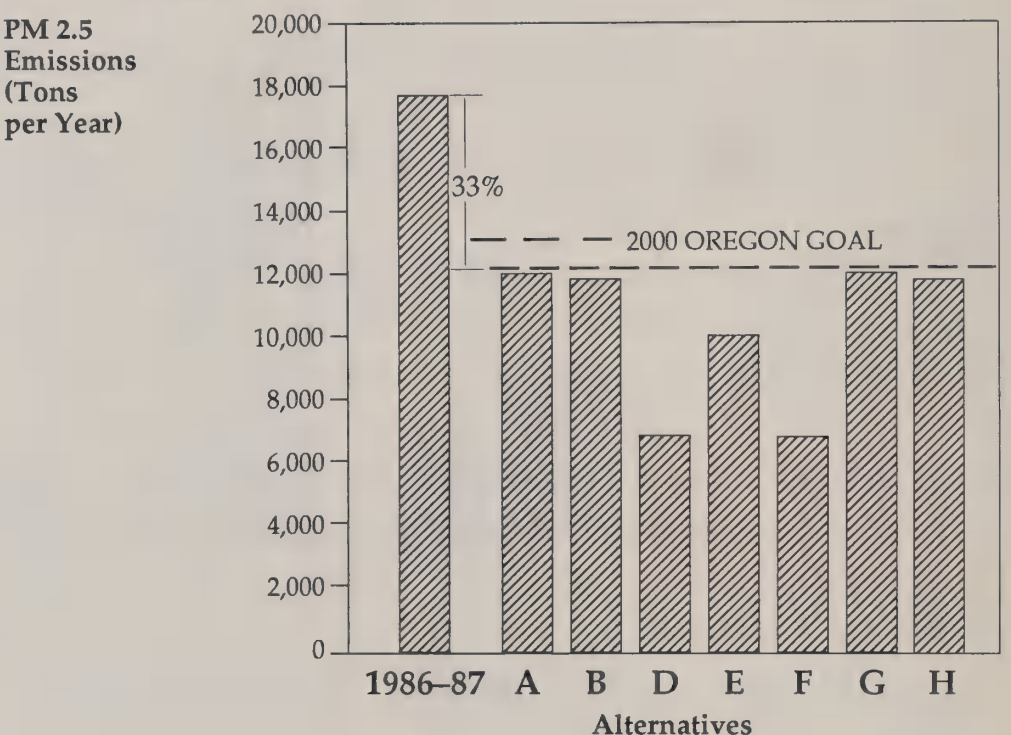


Figure IV–5

Fine Particulate (PM 2.5) Emissions by EIS Alternative Eastern Oregon

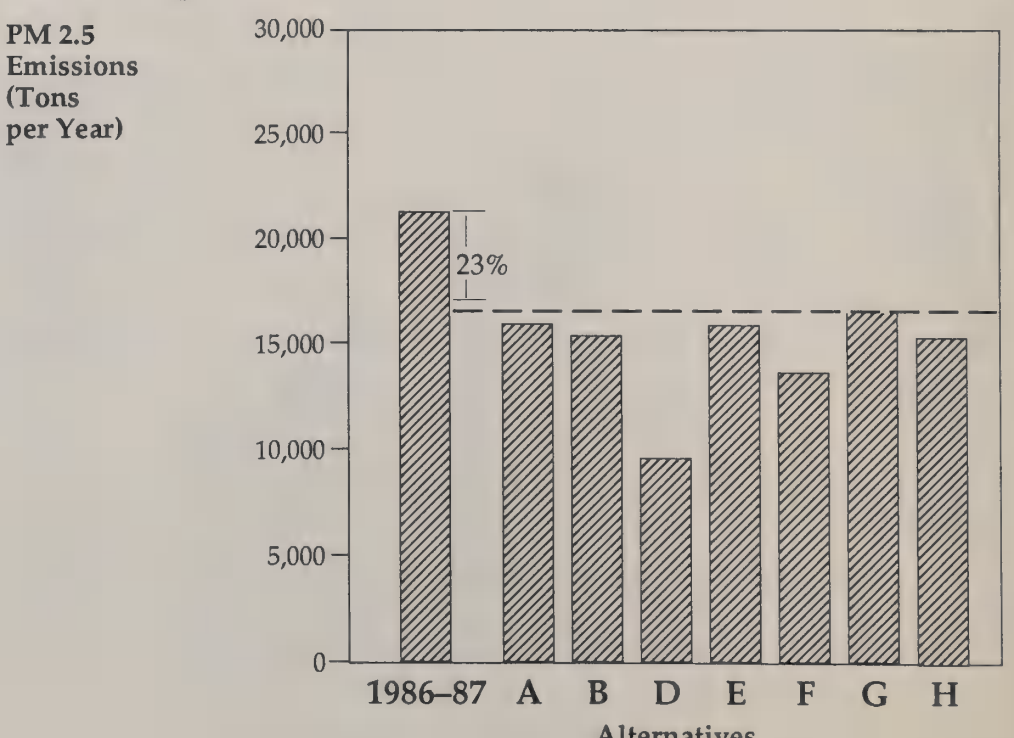


Figure IV–6

Fine Particulate (PM 2.5) Emissions by EIS Alternative
Western Washington

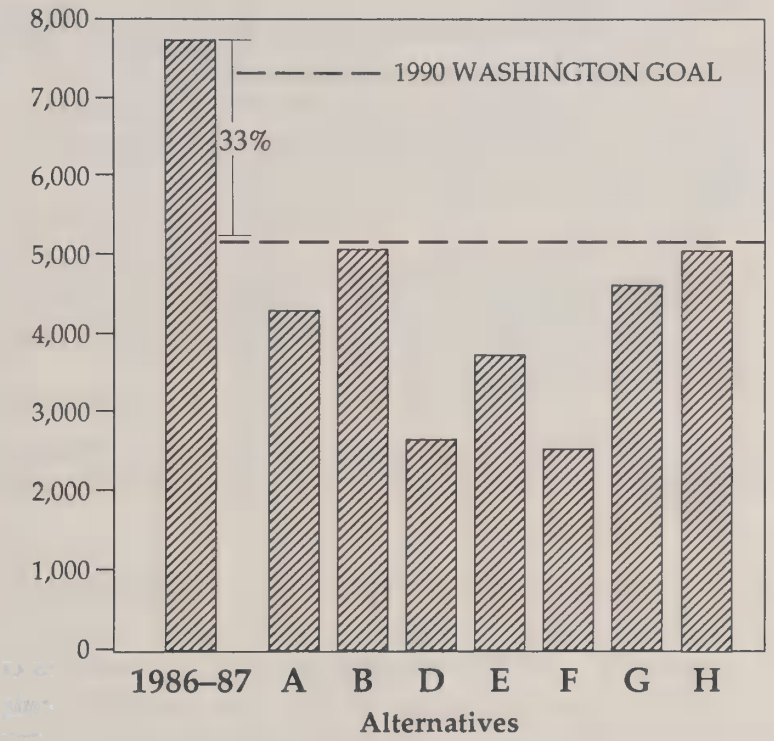
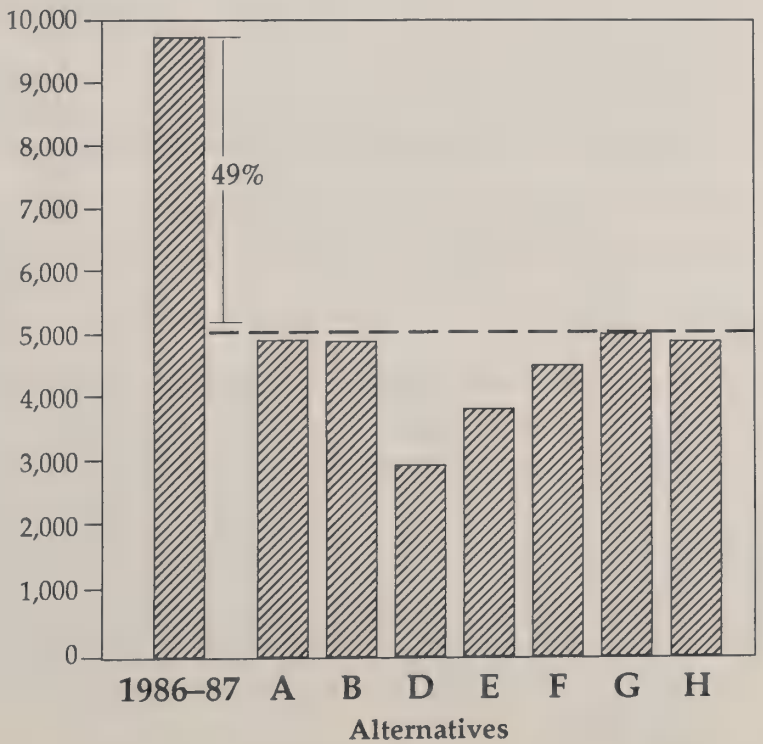


Figure IV–7

Fine Particulate (PM 2.5) Emissions by EIS Alternative
Eastern Washington



Subregional Emissions

The emissions analysis compares the modeled subregional emissions totals for the eight alternatives to the modeled subregional 1983-1985 emissions totals.

The 1983-1985 baseline annual particulate emissions and the year 2000 emissions for each alternative was modeled for each National Forest. The modeled Forest-level PM2.5 emissions were then aggregated to the subregional level. (PM2.5 refers to particulates 2.5 microns in diameter or smaller.)

The projected changes of the subregional totals, by alternative, are presented in Figures IV-4, -5, -6, and -7. The Regional total of acres prescribed burned, and the amounts of biomass per acre consumed, are presented in Figures IV-2 and -3.

The percent change of the region-wide annual emission total from 1983-1985 to the year 2000 is included in the alternative comparison table in Chapter II.

The prescribed burning fine particulate emissions were modeled for the year 2000, so that progress in reducing western Oregon and Washington emissions under the eight alternatives could be compared to the Oregon total suspended particulate (TSP) emissions reduction target. That target is a 50 percent of the 1976-1979 TSP emission levels by the year 2000.

PM2.5 Emissions

PM2.5 particulate emissions were modeled because it is expected that PM2.5 standards will be promulgated by 1990. Also, the PM2.5 class of particulates is what is important when projecting impacts of prescribed burning on visibility and human health.

To convert modeled PM2.5 values to PM10, multiply by 1.13. To convert to total suspended particulates (TSP), multiply by 1.25.

Projected Prescribed Fire Emissions

Pacific Northwest Region: Average annual emissions for the Region are expected to decline at least 37 percent by the year 2000 compared to 1983-1985 regardless of the alternative selected. The decrease will be due primarily to a decline in acres burned (Figure IV-2) and a reduction in biomass consumed per burned acre (Figure IV-3).

The reduction in biomass consumption will come about through better utilization, a shift from old-growth to second-growth forest management, increased use of mass ignition, and burning at higher fuel moistures.

Western Oregon: Fine particulate emissions for all alternatives will decline at least 33 percent by the year 2000 compared to the present (Figure IV-4). Acres burned will decline at least 18 percent compared to the present (Figure IV-2); and the biomass consumption will decline by at least 17 percent (Figure IV-3).

Eastern Oregon: Fine particulate emissions for all alternatives will decline at least 23 percent by the year 2000 compared to the present (Figure IV-5). Acres burned will decline at least eight percent; biomass consumption will decline at least 23 percent.

Western Washington: Fine particulate emissions for all alternatives will decline at least 33 percent by the year 2000 compared to the present (Figure IV-6). Acres burned will decline at least 24 percent, and biomass consumption will decline at least 10 percent.

Eastern Washington: Fine particulate emissions for all alternatives will decline at least 49 percent by the year 2000 compared to the present (Figure IV-7). Acres burned will decline at least 23 percent; biomass consumption will decline at least 27 percent.

Wildfire Emissions

Wildfires typically consume three times as much fuel per acre as prescribed fires. They may produce two to ten times as much fine particulates as prescribed fires because wildfire combustion efficiency is typically lower (Ward et al.,1976).

However, wildfire emissions were not included in the analysis for two reasons:

1) there are no federal or state emission standards for uncontrolled sources such as wildfires; and

2) there is no basis for projecting differences in wildfire acres among the alternatives.

The argument for this choice is presented in the preceding section of this chapter.

PSD Increments

Part C of the Clean Air Act—Prevention of Significant Deterioration (PSD)—requires that increases of total suspended particulates and sulfur dioxide will not exceed annual increments published for Class I, II, and III areas. Since the particulate emissions for all subregions are projected to decrease under all alternatives, prescribed burning is not expected to "use up" any portion of the PSD increment of a particular area.

Ambient Air Quality Particulate Standards

Annual particulate emissions from prescribed burning are expected to decrease below current levels in the four subregions under all alternatives. Therefore, air quality as measured against published annual particulate standards, will be maintained or improved. Thus, it is safe to conclude that the annual particulate concentration problems of nonattainment areas will not be aggravated.

Visibility Protection of Class I Areas

Oregon and Washington state implementation plans contain short-term and long-term strategies for improving Pacific Northwest visibility. (See the Air section in Chapter III.)

The short term strategies of both states include restricting prescribed burning in order to produce immediate improvement in Class I area visibility during the peak summer recreation period from July 4 through Labor Day.

The long-term strategies were designed to assure reasonable progress toward the national goal of improving visibility by reducing particulate emissions from prescribed burning. Oregon long-term strategies include the previously-mentioned goal of 50 percent emmissions reduction, comparerd to 1976-1979 levels in western Oregon, by the year 2000. The Washington goal is to reduce prescribed burning emissions in western Washington by 35 percent of the 1976-1979 levels by 1990.

The emissions analysis projects the aggregated emissions from western Oregon National Forests to be at least 33 percent less than the 1984 level, and 61 percent less than the 1976-1979 level. As of 1984, a 30 percent reduction had been achieved in western Washington (Sandberg et al.,1985). An additional 33 percent reduction in emissions is projected by the year 2000 under all alternatives, bringing the minimum possible reduction to 63 percent of the 1976-1979 level.

Meeting the Standards

Despite the favorable projections of reduced annual subregional particulate emissions for all alternatives, 24-, 3-, and 1-hour ambient particulate standards may be violated, and Class I area visibility may be seriously affected by an individual prescribed fire. Care will be exercised under all alternatives to burn only when smoke advection and dispersion conditions are favorable; compliance with daily state smoke management direction will assure the best possible decisions.

Forecasts of the meteorological factors that affect smoke behavior are fallible; hence this does not extend a guarantee that smoke incursions into Class I areas and communities will not occur. However, the projected annual subregional particulate emissions does give us assurance that Pacific Northwest air quality will improve.

Water Resources

Manual Methods

Manual clearing, chopping, and weeding have a low potential for adverse impacts on water resources. Proper sanitation and precautions to prevent oil and fuel from power tools from entering streams will prevent adverse impacts on water resources from these methods.

Mechanical Methods

Potential Direct and Indirect Effects

Increased sedimentation may result from mechanical methods of vegetation management, depending on operating practices, slope steepness, and distance to the stream channel.

Discussion

First-order stream channels (the upper reaches of a stream where the channel begins) are most likely to be affected by mechanical piling of slash, scarification, etc., since these channels are small and often located within the treatment area. In order to protect channel stability, slash will not be piled within the high water mark of stream channels. Operation of equipment within stream channels is not necessary for vegetation management.

Operating practices designed to prevent adverse impacts on soils will also prevent impacts on water quality. These practices include timing restrictions; avoiding sensitive soils (especially in municipal watersheds); and limiting equipment to slopes of less than 35 percent. Protective buffer strips will be left along streams, lakes, and wetlands to act as a filter mat to minimize sedimentation from off the site due to upslope soil disturbance (see Chapter II, Mechanical Methods, Mitigation Measures).

Conclusion

While there is a potential for adverse impacts on water quality, most impacts can be avoided by implementation of the mitigation measures. All alternatives involve use of mechanical methods of

vegetation management. Alternative C and D, respectively, would treat 78 and 35 percent fewer acres using mechanical methods than would be treated under Alternative B (see Table IV-3, soils discussion, this chapter). These alternatives would pose a lower risk of sedimentation from mechanical methods than Alternatives A, B, E, F, G, and H.

Prescribed Burning

Potential Direct and Indirect Effects

Possible impacts from burning, if it is severe enough to produce unwettable (hydrophobic) soils, include increased sedimentation, increased nutrients leached from ashes, and increased runoff during storm events. For more information, see the soils discussion in this chapter.

Discussion

The highest potential for accelerated sedimentation is where a small, first-order stream runs through a treatment area. Eroding soil can collect in the small stream and be routed to larger, fish-bearing streams.

Practices that protect the soil resource will also prevent adverse effects on water quality and quantity. An unburned buffer of vegetation along Class I, II, and III (year round) streams will provide a filter to prevent excessive sediment from entering streams. It also will protect riparian vegetation, which provides shade and bank stabilization. Methods to reduce the severity of prescribed burning will also be utilized to reduce damage to soil and resulting erosion. (See the section in Chapter II on mitigation measures for prescribed burning.)

Conclusion

Prescribed burning generally does not affect water yield, erosion, or water quality during storm runoff except where severe fire causes unwettable soils and leads to accelerated erosion (Douglass,1981), or in cases where prescribed fires escape. All alternatives include practices to prevent severe prescribed burns or escaped fires that can lead to this condition.

Alternative C prohibits the use of fire as a vegetation management technique. Alternatives D and F significantly reduce (40 and 15 percent, respectively) the number of acres treated with prescribed fire, compared to acres treated under Alternatives A, B, E, G, and H. (See Table IV-4 in the discussion of effects on soil in this chapter.) With implementation of the mitigation measures, none of the alternatives are expected to cause adverse effects on water quality due to prescribed burning.

Biological, Cultural, and Grazing Methods

Potential Direct and Indirect Effects

Livestock grazing may lead to increased sedimentation or increased fecal bacteria, both of which can create unsafe drinking water. (See Human Health Risk section.) If riparian areas are overgrazed, increased stream temperatures and channel instability may result. Peterson (1983) found that sheep grazing on clearcut units on the Siuslaw National Forest led to a significant increase in fecal coliform concentrations downstream.

Direction found in Forest Service Manuals 2200 (Range Management) and 2500 (Watershed Management), and in individual Forest land management planning documents, is designed to minimize adverse impacts. Fencing and upslope water developments can be used to keep livestock out of riparian areas. Impacts on downstream domestic water users and water quality monitoring requirements must be incorporated in the project-level plan.

Other biological methods, such as seeding of desired species, will serve to prevent soil erosion and have a beneficial effect on water quality.

Conclusion

Grazing for vegetation management would be used on a maximum of 18,700 acres in any of the alternatives. This amounts to less than 0.1 percent of the Region's acres. The use of biological methods of vegetation management, as implemented under any alternative, is not expected to result in adverse effects on water quality.

Herbicides

Potential Direct and Indirect Effects

Use of herbicidesmay result in contamination of surface water from aerial drift, accidental spills, or surface runoff. All alternatives involving use of herbicidesrequire unsprayed buffers of vegetation to be left adjacent to live streams, lakes and wetlands (see Chapter II, Herbicides, Mitigation Measures). Therefore, indirect effects on water quality due to loss of riparian vegetation, such as increased stream temperatures or loss of channel stability, are not expected.

Discussion

Once in the environment, a chemical herbicide is subject to degradation by soil microorganisms; chemical-and photo-degradation; adsorption onto soil particles and organic matter; volatilization from soil, plant or water surfaces; or uptake by plants (U.S. Environmental Protection Agency, 1980).

For an herbicide to reach surface or groundwater, it must be relatively soluble in water; resistant to adsorption by soil and organic matter; and sufficiently persistent to endure until it enters the water (Newton and Norgren,1977).



The use of herbicides may result in contamination of nearby surface water. Thus, monitoring of water quality is an important component of any herbicide application program.

Table IV-9 in the section on soils displays the persistence, adsorption, and solubility characteristics of the 16 herbicides, and provides a rating of relative susceptibility to water transport (mobility rating) based on these characteristics.

Of the various techniques for herbicide application, aerial applications presents the highest hazard for surface water contamination. Direct application and drift are the principal ways herbicides reach surface waters (Norris and others,1983). Herbicides could reach relatively high concentrations for a short duration through direct application or drift.

Wet, marshy areas generally receive higher levels of herbicides for longer periods of time than upland areas, as a slight rise in the water table can flush large quantities into stream systems (Norris 1980). Also, there is less opportunity for mixing and dilution in lakes and wetlands, compared to flowing streams.

Mitigation measures to prevent direct application and drift include methods to generate the optimum droplet size to reduce drift; restrictions on environmental conditions which would increase drift; and careful demarcation of unsprayed buffer strips on all live streams, lakes, and wetlands (see Chapter II, Herbicides, Mitigation Measures).

The actual concentration in surface water from direct application depends on the rate of application, depth of water, and interception by overhanging vegetation. For example, if four pounds of active ingredient per acre were applied to a 2-foot deep stream with no overhanging vegetation, the instantaneous peak concentration in the stream upon direct application would be 736 ppb (parts per billion). However, this direct application should not occur if "no-spray" buffers are marked and other mitigation measures are followed.

Drift of chemicals is the more likely means of entry into surface waters. Application factors such as nozzle type, emulsion, wind speed, temperature, and relative humidity affect the occurrence of drift.

A 100-foot buffer is the minimum required for aerial application adjacent to Class I, II, and III streams (see Chapter II, Herbicides, Mitigation Measures).

A 100-foot buffer would result in less than 2 percent of the direct overflight concentration from a helicopter (applying herbicides at a high volume in a 1-10 mph cross wind) reaching the stream (Newton and Norgren,1977). This would amount to 15 ppb in a 2-foot deep stream when the chemical is applied at four pounds per acre.

A 200-foot buffer, as required on all lakes and wetlands, would result in less than 1 percent (of the direct overflight concentration) reaching these areas.

As the peak concentration travels downstream, it would diminish due to dispersion, chemical degradation, and adsorption of chemicals to sediments and organic matter (Lorz and others,1979). Dilution by tributaries will also reduce the concentration. For example, if streamflow within the 100-foot buffer is 2 cubic feet per second, and downstream at a water intake the flow is 10 cubic feet per second, then the peak concentration would be reduced from 15 ppb to 3 ppb at the intake.

For methods other than aerial application (such as a truck-mounted sprayer used for roadside spraying), chemical application is prohibited within 50 feet of surface water (see Chapter II, Herbicides, Mitigation Measures). Drift from truck-mounted and backpack sprayers can be controlled more closely than aerial application.

Mobilization of herbicides in ephemeral stream channels can be an important mechanism for chemicals to enter surface waters if precipitation prior to chemical degradation is sufficient to cause streamflow. This can result in relatively low concentrations for longer durations (Norris and others,1983).

Project-level analyses will consider the potential for overland flow or mobilization of herbicide residues in dry stream channels when determining appropriate treatment of the streamside area along dry (intermittent) Class IV channels, flowing streams, or lakes.

Herbicides also may reach surface water by overland flow. Overland flow is rare in the forest environment (Harr,1976). The bare, compacted soils where it does occur are unlikely to be treated with chemicals (Norris and others,1983).

Where runoff does occur, the concentration of herbicide may decrease as it flows over the unsprayed areas adjacent to stream channels (Norris,1981a). Nearly all chemicals are applied from March through October, so the highest hazard for mobilization of residues from overland flow (or mobilization in ephemeral channels) would be during spring (March to May) runoff events or early fall rain-on-snow events.

Leaching of herbicide residues depends on soil type, organic matter content, herbicide solubility in water, rainfall, and chemical persistence. Most herbicides are relatively immobile in soils and do not persist long enough to travel more than a short distance through the soil (Norris and others,1983). However, in agricultural uses, pesticides and herbicides have leached into aquifers, resulting in contamination.

Due to the low frequency of application and wide dispersion of treatment units (a maximum of 0.2 percent of National Forest lands within the Region per year would be treated using this method under any alternative), the risk is much lower.

The width of the untreated buffers makes it unlikely that chemicals would reach surface waters through subsurface flow. However, there are some unknown factors influencing the possibility of groundwater contamination. For example, herbicides may persist in anaerobic conditions found below the water table, where soil microorganisms are no longer present to assist in degradation (U.S. Environmental Protection Agency, 1986).

Groundwater contamination is more likely in areas with high water tables, or at tree nurseries (covered in a separate EIS) where frequent applications could occur. The low frequency of herbicide application and absence of static groundwater under most forest areas makes the hazard of groundwater contamination low.

Once in the aquatic environment, herbicides may be volatilized. Adsorption on stream sediments or aquatic biota may take place.

Herbicides may also be degraded by chemical, biological or photo-chemical means, or passed downstream. (Newton and Norgren,1977).

In six years of project water monitoring, phenoxy herbicides never exceeded 0.1 milligram per liter (1 mg./l., equivalent to 1,000 parts per billion (ppb)) in western Oregon streams (Norris,1981a). In water

Table IV-10

Maximum Concentrations of Herbicides Reported under Conditions Found in the Pacific Northwest

Herbicide	Maximum Concentration (parts per million)	Duration of Detectable Residue	Situation
2,4-D	0.132	1 week	live stream, no buffer (1)
2,4-D	.025	1 week	live stream downstream of spray area (1)
2,4-D	0.84	7 ppb after 12 days (1)	flat, marshy area
2,4-D	.071	54 hours	stream flowing through spray area (2)
Glyphosate	no detectable residue		dry irrigation canal banks treated 23 weeks prior to flow (3)
Triclopyr	.006		runoff 5 months after spray and 59" rainfall
Atrazine	.030		after heavy rainfall no buffer (5)
Picloram	0.37	2 storms after application	rangeland where riparian vegetation treated (6)

(1) Norris and Moore 1981

(2) Norris 1982

(3) Comes et al. in USDA-FS 1984

(4) Norris et al. 1976 in USDA-FS 1984

(5) Douglas et al. 1969 in Norris et al. 1983

(6) Davis et al. 1968 in Norris et al. 1983

sampling conducted in 1980-83 on the Rogue River, Umpqua, Gifford Pinchot, Willamette, and Siskiyou National Forests, 235 samples were analyzed. No residues were detected in 203 of the samples; 26 had 0-5 ppb; 4 had 6-11 ppb; 1 had 52 ppb; and 1 had 190 ppb. The preceding table displays monitoring results reported in the literature for the most commonly used herbicides in situations which most closely resemble forest usage.

Accidental spills are another possible route of herbicide entry into surface waters. Mitigation measures requiring location of mixing areas away from surface waters; use of equipment which will not leak; use of a pilot vehicle for tanker trucks; and a Spill Incident Response Plan (updated annually) for prompt response if an accident occurs, will minimize the risk of spillage and water contamination.

Of 17 documented herbicide spills in the Region from April, 1973 to April, 1983, three involved entry into water. Two spills involved helicopters and the entry of 50-100 gallons into small streams. One involved a truck and the entry of 170 gallons into a drainage ditch.

Conclusion

Adherence to the mitigation measures for application of herbicides should reduce the risk of contamination of surface waters. Accidental spills or unpredicted weather conditions during or immediately after application could result in herbicides entering surface waters. To evaluate this risk, project-level analyses are required.

Monitoring techniques can include the uses of tracer dyes, spray contact cards, direct spray observation, and field laboratory analysis. Frequently, direct spray observation (by ground or air) is the most responsive monitoring technique due to timeliness.

Alternatives A and C prohibit use of herbicides Under Alternative E, herbicides would not be applied aerially. This would substantially reduce the risk of chemical contamination of water. All alternatives involving the use of herbicidesfor vegetation management are subject to the same mitigation measures governing the application of herbicides, and should therefore have similar potentials for contamination of water. This risk of contamination may be related to the number of acres treated.

Alternative D allows for limited use of herbicides, with a low risk of water contamination. Increasing numbers of acres are treated under Alternatives E, B, F, G, and H, with corresponding increases in the risk of herbicides entering surface waters.

Cumulative and Synergistic Effects

Analysis of cumulative effects requires a look at the big picture. Potential cumulative impacts on water resources must be considered on a watershed basis. Potential cumulative and synergistic effects include increased sedimentation, changes in the quantity and timing of peak flows, and chemical contamination of surface and groundwater.

Discussion

Reductions in evapotranspiration and interception of rain by vegetation may result in increased soil moisture, which can lead to increased mass wasting, erosion, and change in the timing and quantity of runoff.

Timber harvest, however, is the primary factor in the Region affecting these changes in evapotranspiration and interception. Additional reduction in evapotranspiration and interception caused by killing brush species is small and brief (Everest and Harr,1982).

Rangeland vegetation treatments generally do not cause a change in the quantity and timing of flows. Vegetation management for range and wildlife habitat improvement is done to change species composition, not to eliminate vegetation.

The potential for cumulative buildup of herbicide residues within surface waters due to a variety of vegetation management activities within a watershed is low.

> *Yearly, less than 0.2 percent of National Forest System lands would receive application of herbicides under any of the alternatives. In those alternatives permitting aerial application, less than half of those acres would be aerially sprayed.*

Application of herbicides for site preparation, release, road maintenance, and so on could conceivably occur within the same season within a watershed. The mitigation measures designed to prevent entry of herbicides into water apply to all of these activities.

Flowing water rapidly dilutes herbicide concentrations. Fast-moving streams with substantial roughness and a stair-step profile dilute peak concentrations rapidly (Newton and Norgren,1977). The previous table showing monitoring results associated with commonly used herbicides illustrates their short-lived nature in forest and rangeland streams.

There is a potential for buildup of herbicide residues in groundwater where numerous sites (all feeding the same aquifer) are treated. Generally, however, dispersion of activities makes this unlikely.

Atrazine, bromacil, dinoseb and simazine have been detected in the ground water in several Great Plains and Eastern states. These occurrences have been related to agricultural land applications, which involve a much higher frequency and rate of application than forestry uses (U.S. Environmental Protection Agency,1986).

Information on the fate of herbicides in groundwater is insufficient to determine the potential for impacts on water quality. Groundwater monitoring will be conducted if there is potential contamination of an aquifer used as a domestic water supply. The potential for impacts on domestic water supplies will be considered in project-level analyses.

Conclusion

Dispersion of activities within a watershed is the key to avoiding substantial cumulative impacts. Vegetation management activities in any of the alternatives in a given year will occur on less than 2 percent of the National Forest lands. However, dispersion of these activities cannot be evaluated at the Regional level. Project-level plans will evaluate dispersion of activities within a watershed.

Activities on lands owned by others and the effects of other activities on National Forest lands (such as road construction, timber harvest, and grazing) will be considered when planning projects under all of the alternatives.

Project-level analyses will include an analysis of the cumulative effects on a watershed. This takes into account other past and present activities in the watershed as well as protection of existing uses such as domestic, municipal, or irrigation water supplies.

All alternatives meet existing Regional direction for protection of water resources. The alternatives will also meet or exceed the requirements of the Washington, Oregon, and California Forest Practices Acts. Existing cooperative agreements with other agencies involving formally designated municipal watersheds will not be affected.

Changes in water quality and quantity can affect aquatic ecosystems, livestock, and wildlife, and domestic, industrial, and irrigation users. See the discussions on fisheries and wildlife in this chapter.

Chapter 4
Environmental Consequences

- Timber Yields
- Rangeland Vegetation
- Noxious Weeds
- Diversity
- Threatened, Endangered, & Sensitive Animal & Plant Species
- Effects on Wildlife
- Riparian Resources & Fisheries
- Specific Lands & Areas
- Insect & Disease Conditions
- Land Uses
- Recreation
- Facilities
- Rights-of-Way
- Scenery
- Cultural Resources
- Energy Consumption & Production

Timber Yields

Timber yield effects are directly related to the program effects described in Appendices A (Timber Growth and Yield Effects), C (Herbicide Use and Efficacy), and E (Effects on the Silviculture Program).

Vegetation management for site preparation or conifer release affects the establishment and early growth of regenerated stands. A change in silvicultural regimes (such as elimination or restriction of a vegetation management technique) can have the effect of reducing timber yields achievable from some sites. Eventually, these reductions will lead to adjustments in timber harvest levels.

When these timber growth and yield effects are aggregated on a Forest level, it results in a reduction in long-term sustained yield. This may or may not result in a change in the allowable sale quantity (the timber sale program) within the decade covered by an approved timber management or land management plan.



A change in silvicultural regimes–such as elimination or restriction of a vegetation management technique–can have the effect of reducing timber yields from some sites.

When and how these adjustments in harvest levels will result is based on a number of variables that can only be addressed by individual National Forests. Changes in the amount or effectiveness of silvicultural activities, however, will have real effects on the projected supply of available timber.

In this analysis, these effects will be expressed as the predicted change in long-term sustained yield levels.

Actual harvest level adjustments will be assessed by each individual National Forest. In most situations, only that component of the available land base being managed for full or nearly full potential timber growth and yields would be affected.

On lands programmed for less than maximum timber yields (to emphasize other important resource values and management concerns), effects such as tree stocking reductions, loss of commercial thinning opportunities, and extended stand rotation periods can normally be accommodated while continuing to meet the lower timber output targets.

The relationship of the programmed timber harvest level (allowable sale quantity) under an approved management plan to the potential long-term sustained yield level will normally determine the need for adjustments.

For example, on a Forest where the allowable sale quantity is essentially the same as the potential long-term sustained yield level, a reduction in the long-term sustained yield level could trigger an immediate reduction in the timber sale program. This set of circumstances, however, is not the typical case for most Forests in the Pacific Northwest Region.

Other variables, such as timber management harvest priorities; opportunities for rescheduling between Forests; departures from the nondeclining even-flow policy; or the rate at which growth rates are building toward site potentials can affect the actual allowable sale quantity. For these reasons, a comprehensive Forest-level analysis would be needed to translate per-acre growth and yield effects into Forest-level timber harvest adjustments. Subregional effects are estimated following the discussion of effects for each alternative.

Currently in the western United States, there are three environmental analyses underway which are aimed at resolving vegetation management issues: this EIS; one by the Bureau of Land Management (BLM) in Western Oregon; and one for the Pacific Southwest Region of the Forest Service. One of the key questions being addressed in each document is the relationship of the use of herbicides to timber growth and yield.

In an effort to coordinate all three analysis efforts, a meeting was held to evaluate the similarities and differences among the timber yield analyses and their resulting estimates.

Major Conclusions

- All of the analyses are adequate for the evaluation of relative differences between EIS alternatives. The information is sufficient to make the decisions being considered in each particular EIS.
- The state-of-the-art of managing competing vegetation is different in different locations and for different vegetation types.
- Cost factors are different in different locations.
- Small differences were found in management and analysis for similar vegetation types.

Key reasons for differences in final yield estimates were primarily the large differences in different geographic areas managed by each organization. This results in different needs for managing competing vegetation for reforestation.

The Pacific Northwest Region has a smaller proportion of its most productive timberland in sites where competing vegetation is a major problem, compared to the Pacific Southwest Region of the Forest Service, and the Bureau of Land Management in Oregon. Therefore, on a regional basis, there is only a moderate reduction in long-term sustained timber yields—an estimated 5 percent—with a complete absence of herbicide use. (See Appendix A, Timber Growth and Yield Analysis).

On the other hand, both the BLM in Oregon and the Pacific Southwest Region have a somewhat larger proportion of their most productive timberland in areas where competing vegetation is a management concern. Therefore, on a regional basis, they found a greater reduction in timber yield due to not using herbicides.

Other less significant reasons for yield differences were attributed to different growth models or yield simulations used in the various analysis. A variety of other factors discussed were found to be less important in contributing to yield differences. These included rotation lengths, economic assumptions and cost factors, substitutability of methods, stratification logic, seedling growth or mortality effects, and land suitability adjustments.

Predicted Change in Long-Term Sustained Yields by Alternative

Alternative A

The suspension of herbicide use will result in a reduced effectiveness of treatment for some silvicultural prescriptions. This is primarily due to a reduced duration of vegetation control when dealing with target vegetation that has a potential for aggressive site re-occupancy. For example, on the average Regionwide, it has taken an estimated 1.8

manual cuttings (compared with 1.1 herbicide treatments) to adequately meet prescription release objectives.

THE PREDICTED CHANGE IN LONG-TERM SUSTAINED YIELDS IS ESTIMATED TO BE MINUS 5 PERCENT. THIS WOULD REPRESENT APPROXIMATELY 190 TO 215 MILLION BOARD FEET ANNUALLY.

Appendix A (Timber Growth and Yield Analysis) contains a detailed assessment of short-term growth reduction and tree mortality in several major vegetation complexes, following the suspension of herbicide use.

Reduced treatment effectiveness would occur on sites with well-established tanoak and madrone. There will also be a slight reduction of site preparation or conifer release effectiveness in control of ceanothus species and herbaceous vegetation in certain situations. Yield reductions related to the loss of herbicides would be concentrated in the southern Cascades and Siskiyou Mountains, and a portion of the southern Coastal subregions. There will also be minor impacts on Forests within the Transition and East-side subregions.

Effects on budget levels: The implementation of Alternative A assumes an increased budget allocation for silvicultural activities. This is done to accommodate the cost effect of a shift from herbicide use to alternative methods of site preparation and conifer release.

This reflects the most likely implementation strategy, should Alternative A be selected, and also displays the importance of these activities in the timber management program.

All Forests were asked to assess the impact if budget were held constant, resulting in a reduced silvicultural program of work under Alternative A. Results indicate that an additional 1-1/2 percent reduction in timber yields would eventually occur.

This means that Alternative A under a constrained budget will result in roughly a 6-1/2 percent eventual reduction in timber yields—reflecting the reduced effectiveness of treatment in some situations, plus an increased cost-of-doing-business.

Alternative B

This alternative is used as a reference for the evaluation of other alternatives. THEREFORE, THERE WILL BE NO CHANGE IN LONG-TERM SUSTAINED YIELDS.

The anticipated allowable sale quantity from Pacific Northwest Region Forests has been estimated at 3.8 to 4.3 billion board feet per year in the near future, as Forest Land Management Plans are developed and implemented. This figure provides a frame of reference for the magnitude of change between the other alternatives.

All vegetation management tools and techniques are available for use in the appropriate environmental setting under Alternative B. This will eventually translate into a high level of timber yields.

Alternative C

The lack of vegetation management for reforestation will result in severe falldowns in long-term sustained timber yields.

THIS PREDICTED REDUCTION IN LONG-TERM SUSTAINED YIELD IS ESTIMATED TO BE BETWEEN 25 AND 50 PERCENT. THIS REPRESENTS APPROXIMATELY 1 to 2 BILLION BOARD FEET ANNUALLY.

Appendix A (Timber Growth and Yield Analysis) contains a detailed analysis of yield effects in six major vegetation complexes. This scheme of management (i.e., reforestation efforts without early control of competing vegetation) may be inconsistent with National Forest Management Act requirements regarding a reasonable assurance of timely stand regeneration. There would also be major changes in the allocations of timberland designated suitable for management designations on National Forests, due to the high risk of regeneration failures under this alternative.

Alternative D

In the short term, the added caution and reduced tolerance for data gaps and uncertainty will result in lower accomplishment of site preparation and conifer release activities. For example, estimates from the 19 National Forests indicate that 12 percent of the silvicultural diagnosis would result in a no-treatment or deferred action decision under Alternative B. Under Alternative D, however, an estimated 26 percent of these prescriptions (15,000 acres per year) would be a deferred or no-action decision. (See Appendix E—Silvicultural Program Effects.)

The Forests indicate that knowledge gained through an increased emphasis on research and monitoring will tend to make vegetation management more effective and efficient in the long term. Management emphasis under this alternative (and Alternative H) would

probably encourage more activity in the development of problem prevention schemes for site-specific situations.

THE EVENTUAL EFFECT ON LONG-TERM SUSTAINED TIMBER YIELDS IS ESTIMATED TO BE A 1-1/2 TO 2 PERCENT REDUCTION; OR APPROXIMATELY 55 TO 85 MILLION BOARD FEET PER YEAR.

Alternative E

Aerial herbicide applications are discontinued and manual treatments are more restricted under this alternative. Suspensions or restraints on individual herbicides will also be imposed. The effectiveness of vegetation control for reforestation will be reduced on steep terrain and on sites occupied by tall or dense competing vegetation.

Assessments made by the 19 Forests indicate that a slight increase in deferred action or no-treatment decisions will occur in comparison with Alternative B(approximately 1,000 acres per year).

THIS IS ESTIMATED TO TRANSLATE INTO A EVENTUAL CHANGE IN LONG-TERM SUSTAINED YIELD OF MINUS 1 TO 1-1/2 PERCENT OR APPROXIMATELY 35 TO 65 MILLION BOARD FEET PER YEAR.

Alternative F

The loss of prescribed burning as a site preparation method will have negative effects on the success of reforestation efforts in a few situations. Appendix E (Silvicultural Program Effects) contains an analysis of the role of fire in the reforestation program. The principal effect leading to reduced timber yields is an increase in non-stocked or poorly stocked inclusions within managed stands. Primarily, this would occur where concentrations of brush or logging residues create physical obstructions to planting. Projected timber yields from such stands would be adjusted downward to accommodate the lower tree numbers and poor spatial distribution effect.

BASED ON FOREST ESTIMATES, THE ELIMINATION OF BURNING FOR SITE PREPARATION WILL TRANSLATE INTO A 2-1/2 TO 3 PERCENT REDUCTION IN LONG-TERM SUSTAINED YIELDS, OR APPROXIMATELY 95 TO 125 MILLION BOARD FEET PER YEAR.

Less significant consequences under this alternative would include reduced tree growth and vigor in some newly established stands. Region-wide, this would have limited impacts on future timber yields

(see Appendix E), but could cause disruptions at the Ranger District or timber compartment level of project planning.

Forests within the Coastal and southern Cascades subregions would be most affected under this alternative.

Alternative G

The enlarged program of work for site preparation and conifer release would eventually translate into an increase of long-term timber yields in some situations (see detail in Appendix E). For example, there is a 12 percent increase in cultural treatments in comparison with the other alternatives.

THE FORESTS ESTIMATE THAT THIS INTENSIFIED MANAGEMENT WILL LEAD TO A 2-1/2 TO 3 PERCENT INCREASE IN LONG-TERM SUSTAINED YIELDS, OR APPROXIMATELY 95 TO 125 MILLION BOARD FEET PER YEAR.

An improved trees-per-acre stocking level in some difficult reforestation conditions is the primary beneficial aspect seen under this alternative. Most of the intensified management efforts would be directed at lands that are considered only marginally suitable for regulated timber harvest. This would often mean that some cost efficiency would be sacrificed, and that the risk of long-term productivity damage on some fragile sites would be somewhat increased. An example of such a situation might be the conversion to regulated timber harvest of some non-commercial hardwood stands in the southern Cascades, growing on sites with skeletal or poorly developed soil profiles.

Alternative H

Due to a moderate increase in the number of acres receiving no-treatment and deferred treatment diagnosis decisions under Alternative H, the potential short-term effect on timber yields (compared to Alternative B) would be roughly a 0.5 percent decrease, or about 20 million board feet per year. The reduced program size represents a tradeoff with the knowledge gained, and over time, better definition of damage thresholds. In terms of long-term sustained yields, the effect under Alternative H should be negligible.

Alternative H is essentially a combination of the intent of B and D, along with a few specific elements of Alternative E. Potential timber yield effects under H would be related to these features:

1. Three herbicides (amitrole, diuron, and fosamine) will be suspended from use.

2. All tools and techniques are permitted, but herbicides will be used only when necessary to meet management objectives.

3. Emphasis on the development of preventive strategies and restraint in the face of uncertainty will probably lead to a modest reduction of program size (more site preparation and conifer release diagnosis is expected to lead to non-treatment or deferred decisions) under Alternative H.

Regarding the availability of diuron and fosamine, neither compound has had regular use in the silvicultural program (see Appendix C—Herbicide Use and Efficacy). Diuron is a soil sterilant and has been a small component of the right-of-way maintenance program. Fosamine is not currently labeled for conifer release and has had only limited use as a site preparation compound, usually for salmonberry control. Use in the Region has been primarily for roadside treatments. Loss of these herbicides will not measurably affect the silviculture program.

The availability of all methods under Alternative H will afford the flexibility needed for the silviculture program. Use of herbicides is expected to drop by an estimated 7,000 acres annually in the plantation maintenance program and remain stable for site preparation in comparison with Alternative B. Chemical use in the silviculture program is expected to be reduced by approximately 25 percent in comparison with levels seen during the 1979 through 1983 period (see Appendix E, Silviculture Program Effects). Silviculturists should have the latitude needed to meet site-specific prescription objectives under Alternative H.

Increased emphasis on monitoring, preventive strategies, and restraint in the face of major data gaps will probably increase the no-treatment and deferred treatment diagnosis decisions to a moderate degree under Alternative H. No-treatment prescriptions are expected to increase to 18,000 acres annually, in comparison with 11,000 acres under Alternative B. This represents about 20 percent of the total yearly site preparation and conifer release.

The reduced program size represents a tradeoff with knowledge gained, and over time, better definition of damage thresholds. Estimates of short-term effects on timber growth and plantation success, as they would translate into program effects, are shown in Table IV-12. Yields would be reduced by roughly .5 percent in the short-term,

representing approximately 20 million board feet annually. In terms of long-term sustained yields, the effect under Alternative H should be negligible.

Three generalizations can be made about the possible short-term (allowable sale quantity) effects under this alternative.

First, they are small when viewed in context of the anticipated (Region-wide) timber harvest program of four billion board feet currently projected for the proposed Forest land management plans. The predicted effect of minus 0.5 percent, in fact, is well within the acceptable statistical error terms established for Forest Plan timber yield tables.

Second, the effects are highly speculative when viewed in the context of tradeoffs, such as improved monitoring programs and efficiencies gained through the use of preventive vegetation management strategies in the long-term.

Finally, there will be timber harvest rescheduling opportunities between adjacent Forests and between suitable timberland allocations within each National Forest which may allow mitigation of this minor falldown.

On balance, the factors lead to a conclusion that no timber yield effects, either short-term or long-term, are likely to be seen under Alternative H.

Subregional Timber Yield Effects

The variation in potential long-term sustained yield among the alternatives for the Region as a whole is comparatively small, ranging from a maximum reduction of 4-1/2 percent to a maximum increase of 3 percent (with the exception of Alternative C, the "no action" alternative).

Larger variation will occur from Forest to Forest between the alternatives. Assessing this variation from Forest to Forest is difficult. This is because current land management planning underway on each National Forest considers alternative management strategies. Each of these land management alternatives is associated with a unique long-term sustained yield level.

The potential differences in long-term sustained yield expected from the vegetation management alternatives considered in this EIS are generally (with the exception of Alternative C) very much less than the differences associated with alternatives being considered in each Forest Plan. For the purpose of this EIS, the estimates of local variation

in long-term sustained yield are made by disaggregating total Regional variation among the alternatives and distributing it proportionately to the subregions, as defined below.

	Subregion	*National Forests*
Washington	Coastal	Olympic
	Western Cascade	Gifford Pinchot, Mt. Baker–Snoqualmie
	Transition	Wenatchee
	Eastside	Okanogan, Colville
Oregon	Coastal	Siuslaw, Siskiyou
	Western Cascade	Rogue River, Willamette, Umpqua, Mt. Hood
	Transition	Deschutes, Winema
	Eastside	Ochoco, Wallowa–Whitman, Umatilla, Malheur, Fremont

The analysis of growth and yield for this EIS (see Appendix A) is comprehensive for the different vegetation complexes assessed for each alternative.

The accuracy of the estimate for Regional variation is sufficient to assess the relative difference among the vegetation management alternatives. While the degree of accuracy for estimates of subregional variations is less, it is still sufficient for assessing the relative difference among alternatives by subregion.

The estimates of changes in yield by subregion were made by disaggregating the variations in yield for the different vegetation complexes. Using this information on a per acre basis (according to the amount of a given vegetation type in each subregion), these variations in yields were then summed for each subregion.

According to the Forest Plans being prepared, there is a great deal of potential variation in long-term sustained yields for subregions, depending on which Forest Plan alternatives are selected. The subregional variation in timber yield for the alternatives considered in this vegetation management EIS are combined with the changes in long-term sustained yield estimated in Forest Plans. The resulting combination shows a range of potential changes in long-term sustained yield for each alternative and each subregion.

These subregional estimates indicate the relative potential for change among the alternatives being considered in this EIS. They do not represent decisions on the allowable sale quantity, nor do they make decisions about allocation of long-term sustained yield to subregions. Allowable sale quantities and long-term sustained yields

Table IV-11

Potential Change in Long-Term Sustained Timber Yield
****MMCF per Year**

Alternative	A	B	C	D	E	F	G	H
Washington								
Subregion								
Coastal	(None)	(None)	–8.9 to 11.9	–.4 to .6	–.2 to .6	–1.8 to 2.4	+.2 to .3	(None)
Western Cascade	–2.2 to -3.8	(None)	–14.7 to 25.8	–.7 to 1.3	–.4 to .6	–1.5 to 2.6	+1.5 to 2.6	(None)
Transition	(None)	(None)	–4.1 to 6.9	–.2 to –.3	–.1 to .2	–.4 to .7	+.1 to .2	(None)
Eastside	(None)	(None)	–9.0 to 15.4	–.5 to .8	–.2 to .4	–.2 to .4	+.2 to .4	(None)
Oregon								
Subregion								
Coastal*	–13.2 to -16.2	(None)	–40.3 to 49.6	–2.5 to 3.1	–4.0 to 5.0	–4.0 to 5.0	+2.0 to 2.6	(None)
Western Cascade*	–12.4 to -17.4	(None)	–82.9 to 115.3	–5.2 to 7.2	–4.1 to 5.8	–8.3 to 11.5	+4.1 to 5.8	(None)
Transition	–2.8 to -4.0	(None)	–17.1 to 24.3	–.9 to 1.2	–.3 to .4	–.3 to .4	+2.6 to 3.6	(None)
Eastside	–6.6 to -9.4	(None)	–39.2 to 56.2	–2.0 to 2.8	–.7 to .9	–2.6 to 3.7	+5.9 to 8.4	(None)

* Yield effects will be concentrated on Forests within the southern portion of the subregion.

**An average Region-wide conversion is approximately 5.18 board feet per cubic foot.

are currently being developed on a Forest-by-Forest basis as part of the land management planning process.

The vegetation management alternative eventually selected for implementation after completion of the Final Environmental Impact Statement (FEIS) may have implications for allowable sale quantities or long-term sustained yields. These implications will be considered on a Forest-by-Forest basis after the preferred alternative is selected in the FEIS.

Changes (related to the vegetation management alternative selected) in an individual Forest's allowable sale quantity or long-term sustained yield will be made through the land management planning process. These changes, if any, could result in issuance of a Supplement to a Forest's Plan, or reissuance of a Draft Forest Plan.

Short-Term Timber Yield Effects

The most serious implications for timber yield (and harvest level adjustment) due to changes in the effectiveness of the stand regeneration and early stand release programs lie in our ability to maintain long-term sustained yields.

A heavy reliance on volumes from regenerated stands is not anticipated for several decades under the harvest scheduling done in support of the Forest land management plans. This is particularly true of those National Forests with their "full-yield" suitable timberland component in a relatively unregulated condition, or with poorly balanced timber age and size class distribution and growth rates below site potentials. For this reason, the timber yield analysis has been focused on the long-term potential. (See Appendix A, Timber Growth and Yield Analysis.)

Concern was also expressed for possible changes in current harvest levels (allowable sale quantity) under the vegetation management alternatives. Each National Forest was, therefore, asked to estimate the possible changes for Alternatives A through G in the Draft EIS. The potential effects from new Alternative H was then developed, using the Forests' analyses.

We emphasized that these effects are simply estimates made to characterize possible implementation needs under an alternative. Actual harvest level adjustment, if any, would be done as part of the Forest planning process.

The questions include: how would the allowable sale quantity (under the preferred alternative of a given draft Forest Plan) change as a result of the alternatives in this EIS? How would potential yields under present timber management plans change?

Criteria for the analysis, coordination direction, and brief descriptions of methodology and rationale are in process records on file at the Forest Pest Management office, Pacific Northwest Region, USDA-Forest Service, Portland, Oregon.

Five general statements can be made regarding the analyses:

1) Other than for Alternative C (no vegetation management), there appears to be little potential for a reduction of the suitable timberland base as a result of management constraints under the EIS alternatives.

2) A reduction in long-term sustained yield in this analysis did not necessarily translate into a proportionate reduction in allowable sale quantity. In other words, current program harvest levels were often less than the long-term potential under the harvest schedules developed under the Forest Plan.

3) Regeneration lags under certain conditions would lead to some lengthening of rotations. A related concern was a reduced opportunity for stocking control, which would lead to lower commercial thinning volumes.

4) The loss of burning as a site preparation tool was viewed as the single most damaging constraint to the silvicultural vegetation management program, particularly by Forests within the East-side and Transition subregions.

5) An important frame of reference for the analysis was the (FORPLAN) harvest schedule needed to bring suitable and available timberlands under a managed condition. Timely reforestation and optimum early growth is fundamental to meeting these schedules.

Table IV-12

Draft Land Management Plan Predicted Allowable Sale Quantities
(By Alternative, in Million Board Feet Per Year)

Forest	A	B	C	D	E	F	G	H
Colville	113	118	95	113	118	95	118	116
Deschutes	197	202	141	199	202	200	210	201
Fremont	125	132	117	125	132	132	139	130
Gifford Pinchot	388	388	380	388	388	388	388	388
Malheur	244	245	195	245	245	220	245	245
Mt. Baker-Snoqualmie	170	170	154	170	170	159	170	170
Mt. Hood	268	268	255	268	268	268	268	268
Ochoco	109	109	108	108	109	109	110	109
Okanogan	66	68	49	67	68	68	71	68
Olympic	186	186	149	184	186	184	188	185
Rogue River	134	137	120	135	135	137	138	136
Siskiyou	149	150	106	150	150	150	150	150
Siuslaw	289	295	221	292	295	289	296	294
Umatilla	154	154	92	139	154	116	156	150
Umpqua	330	340	150	333	312	330	347	337
Wallowa-Whitman	140	143	81	126	143	140	143	138
Wenatchee	133	138	99	136	137	129	139	138
Willamette	557	568	511	568	568	568	568	568
Winema	199	199	199	199	199	199	199	199
Regional Totals	3,951	4,010	3,222	3,945	3,979	3,881	4,043	3,990
(Change from Alternative B)	-1.5%	0	19.6%	-1.6%	-0.7%	-3.2%	+0.8%	- 0.5%

*Alternative H is interpreted from Forest estimates for Alternatives A through G in the Draft EIS.

Table IV-13

Predicted Yields Under Existing Management Plans
(By Alternative, in Million Board Feet Per Year)

Forest	A	B	C	D	E	F	G	H
Colville	110	115	92	110	115	92	115	113
Deschutes	214	219	153	216	219	217	228	218
Fremont	141	148	132	141	148	148	155	146
Gifford Pinchot	411	411	403	411	411	411	411	411
Malheur	269	270	215	270	270	243	270	270
Mt. Baker-Snoqualmie	204	204	185	204	204	191	204	204
Mt. Hood	356	356	339	356	356	356	356	356
Ochoco	109	109	108	108	109	109	110	109
Okanogan	81	84	60	82	84	84	87	84
Olympic	341	341	273	338	341	338	341	340
Rogue River	209	214	188	210	210	214	217	213
Siskiyou	165	168	118	168	166	168	168	168
Siuslaw	427	436	327	432	436	427	443	435
Umatilla	205	205	143	190	154	167	207	201
Umpqua	404	417	183	409	382	404	425	413
Wallowa-Whitman	179	183	103	161	183	179	183	178
Wenatchee	172	177	127	174	176	167	180	176
Willamette	765	797	717	797	797	797	797	797
Winema	156	156	156	156	156	156	156	156
Regional Totals	4,918	5,010	4,022	4,933	4,917	4,868	5,053	4,988

Rangeland Vegetation

The vast majority of rangelands are in the East-side subregion. The Transition subregion has a significant amount, but the Cascade and Coastal subregions have few rangeland acres. Most rangelands in these latter two subregions are categorized as transitory—they are forage opportunities created by timber harvest. Consequently, range improvement projects are conducted almost entirely on the East-side and Transition subregions.



Rangeland improvement activities are designed to have positive effects on the species composition and amount of forage.

Noxious weed control efforts and wildlife habitat improvement projects often provide direct benefits to rangelands. These programs are closely coordinated with range improvement activities to provide mutual benefits and prevent conflicts. See the discussion of noxious weeds and wildlife in the other sections of this chapter.

Range improvement effects on other environmental components (such as water, soil, diversity, or threatened, endangered, and sensitive plant and animals) are discussed in earlier sections of this chapter.

Vegetation management activities and the techniques employed have varying effects on rangeland vegetation and range ecosystems. These effects vary according to factors such as the method used; characteristics of the site where the treatment is applied; timing and intensity of treatment; the size and distribution of the treatment areas; and the sensitivity of the plant species occurring within the project area.

Each method of vegetation management affects rangeland vegetation directly and indirectly through changes in numbers and kinds of plant species. Impacts such as range ecosystem habitat disruption, microclimate alteration, and elimination of nutrient sources can occur. The impacts can be immediate, delayed, short- or long-term, synergistic, or cumulative. Combinations of two or more of these impacts are also possible.

Cumulative effects may occur as a result of combining treatments within a project area; repeating treatments while the effects of previous treatments (changes in vegetation, compacted soil, chemical residues) are still present; and treating different areas within the same project area over a period of time.

The effect and magnitude of these changes on rangeland vegetation can be determined by assessing predicted changes at the project site in relationship to the surrounding landscape. Cumulative effects of projects can then be better evaluated for combinations of treatments or methods.

For example, a range improvement project converting an area dominated by sagebrush to one dominated by grasses and forbs could increase the plant diversity in a landscape of extensive sagebrush stands. If the treatment reduced the only sagebrush existing in the vicinity, however, the effect would be to reduce plant species diversity. If the treatments were planned for annual implementation to cover a larger project area, the effects could be cumulative and might also reduce plant composition diversity.

Vegetation management creates opportunities for improving rangelands as well as creating risks of adverse effects on range ecosystems. The more intensively vegetation is managed, the greater are both risks and opportunities. The risk of adverse impacts of vegetation management on rangeland ecosystems can be minimized by the following means:

- controlling the size, distribution, and number of proposed treatment areas (on a drainage or other geographic basis);
- controlling the selectivity of treatment (through choice of method or the intensity of application) to influence changes in structure and compositionof vegetation; or

- controlling the timing of treatments to reduce effects on a rangeland vegetation species or groups of species. (For example, greater growth of desired species of grasses and forbs that provide forage for wild or domestic grazing animals can be promoted by choosing to do prescribed burning in the spring rather than the fall.)

The specific requirements and mitigation measures selected for a project will depend on site-specific analysis of potential effects and consequences, and on development of rangeland improvement objectives in coordination with other resource management programs and agencies.

Manual Methods

Potential Direct and Indirect Effects

Manual techniques have the lowest potential for direct effects on rangeland vegetation. These techniques have minimal influence on habitat components other than vegetation, and can be selectively applied. The effects of these methods are therefore generally limited to indirect or cumulative effects associated with habitat alteration.

Effects can be controlled to manipulate plant species composition, structure and successional patterns on a project site. These changes may be used to maintain, enhance, or diminish rangeland uses for livestock in the area.

Cumulative Effects

A combination of manual treatments within a project area may have cumulative effects related to the distribution and diversity of plant communities and successional stages. This will cause subsequent changes in an area's rangeland ecosystems.

Conclusion

Manual methods would be used on less than 1 percent of the acres. Alternative C uses the highest proportion of manual methods (20 percent) relative to the other techniques available. Alternative A treats the most acres manually, followed (in descending order) by alternatives E, G, F, H, B, D, and C. The potential for impacts to rangeland vegetation is proportional to the number of acres proposed for treatment.

Mechanical Methods

Potential Direct and Indirect Effects

Mechanical methods have the greatest potential for direct effects on rangeland vegetation. Direct effects are generally limited to the time when activities take place, but may last longer if soils are compacted.

Logging slash or natural accumulations of woody debris may impair access for livestock, thus reducing the use of an area. Removal or strategic placement of some of this material can improve access, allowing the animals to make better use of the forage.

Exposure of mineral soil during mechanical treatments can encourage invasion of plant species adapted to germinate on such sites. These species are often undesired brush or tree species (rabbitbrush or western juniper, for example), and noxious weeds. Sites with bare mineral soil are most susceptible to invasion by noxious weeds. Increases in these species generally lead to degraded rangeland habitat.

Mechanical treatments also provide opportunities to improve rangeland vegetation by providing a good seed bed for establishing high-quality mixes of grasses, legumes, and forbs.

Cumulative Effects

As with manual treatments, a combination of mechanical treatments may have cumulative effects related to the distribution and diversity of plant communities and their successional stages. This will cause subsequent changes in an area's rangeland ecosystems.

Conclusion

The greatest potential for important long-term effects of mechanical methods on rangeland vegetation would result from soil compaction or loss of site productivity. Mitigation measures for mechanical methods (described in Chapter II and discussed in the soils section in this chapter) will be important in limiting adverse effects on rangeland ecosystems.

Mechanical methods would be used on less than 1 percent of the acres. Alternatives A, B, E, F, G, and H would involve similar levels of mechanical methods, and would have similar potential for effects on range. Alternative D would treat 36 percent less area with these methods, with a corresponding reduction in potential effects. Alternative C would reduce use of mechanical methods by 80 percent.

In general, the fewer acres treated with mechanical methods in a given alternative, the less risk there is to rangeland vegetation. However, there is a corresponding loss of opportunity to implement post-treatment habitat improvement activities in those alternatives that limit the use of mechanical methods.

Prescribed Burning

Potential Direct and Indirect Effects

Variations in timing and intensity of fire modify its effects on rangeland vegetation. As with mechanical methods, fire can be used to reduce accumulations of slash, thereby improving access for some animals.

Burning can stimulate growth of plants eaten by livestock and has been shown to improve the palatability of forage for big game (Yoakum et al.,1980). Forage improvement activities are highly dependent on prescribed burning for preparation of a seedbed. This is particularly important in areas where soils, topography, or slope limit the use of mechanical methods for preparing a seedbed.

High intensity wildfires have different effects than most prescribed fires, which typically result in a mosaic of burned and unburned vegetation. These mosaics contribute to habitat diversity.

Cumulative Effects

As with manual treatments, a combination of prescribed fire treatments may have cumulative effects related to the distribution and diversity of plant communities and successional stages. The amount of control that can be applied to treatment areas is less than that of manual and mechanical methods.

Compared to the two previous methods, the use of prescribed fire can result in relatively long-term changes in vegetative conditions over larger areas of land in a much shorter period of time. Consequently, there is more risk if prescribed fire is used without site-specific considerations.

While the use of prescribed fire can have more risk than manual and mechanical methods, it also has some significant advantages. Many vegetation types are closely linked in their development to the influences from the occurrence natural fire.

Fire prescriptions that are designed to mimic natural fire occurrences (combined with the control of how, when, and where the prescibed fire is used) can provide effective rangeland vegetation improvement for forage conditions. Soil and water values that would otherwise be damaged under the conditions typical of hot-burning, uncontrolled wildfires can be protected by controlling prescribed fire conditions.

The use of fire to create more of the "edge effect" is unparalleled by any other treatment method. The edge effect refers to the increased

richness of flora and fauna occurring in the transition zone where two plant communities or successional stages meet and mix. Treatment of large areas (or the combination of a number of small prescribed fire units within close proximity) can result in relatively long-term changes in vegetative conditions. These will cause subsequent changes in an area's rangeland ecosystems.

Conclusion

After the use of herbicides prescribed fire is the second most-preferred treatment method used for improvement of rangeland vegetation. Prescribed burning is used at similar levels in Alternatives A, B, G, and H. Alternatives E, F, and D would treat fewer acres with fire, and Alternative C would make no use of this method for vegetation management.

Habitat improvement opportunities are highest in the alternatives that increase the use of prescribed fire. These opportunities decrease proportionally as the use of fire is restricted.

Biological, Cultural, and Grazing Methods

Potential Direct, Indirect, and Cumulative Effects

The use of these three techniques for vegetation management has the potential to directly affect rangeland vegetation. The potential for indirect and cumulative effects is greater, but it varies with the technique used.

The main emphasis of biological control methods is the utilization of predators, pathogens, and parasites as natural enemies for the control of certain introduced noxious weeds. Because noxious weeds are introduced species, they are virtually free of natural enemies. Thus, biological control agents that evolved in the same ecosystem as the target (host) plant can be used to selectively control individual species of noxious weeds. This only possible because of the "host-specificity" of these agents, which are attracted only to the species with which they evolved.

The majority of cultural control methods used are seeding with grasses and legumes, forbs, and shrub species.

Prolonged or forced grazing of domestic livestock can be used to control the composition or amount of competing vegetation. However, the primary purpose of livestock grazing on rangeland vegetation is for the production of red meat.

Biological Methods

Natural predators, pathogens, and parasites are used to manage vegetation primarily in noxious weed control activities. The release and establishment of these agents for biological control has a very low potential to adversely affect rangeland vegetation either directly or indirectly. The agents released for noxious weed control are species-specific and natural enemies of the weeds.

Presently, 21 species of noxious weeds are targeted for control in the Pacific Northwest. It takes an average of three to five years for biological control agents to become established at selected sites, although their efficacy increases over time. While acres of land may be still considered to be "affected" by the noxious weed, the agents have reduced infestations below economic injury and threshold levels.

Plants targeted for control are usually non-native, toxic to many wildlife species, or compete with preferred forage plants.

Seeding and Planting

Successful seeding of grasses, legumes, and forbs or planting of shrubs depends on preparation of an adequate seedbed. The most common methods are mechanical site preparation and prescribed burning. The effects of these methods were previously discussed in this section. Seeding is generally used in combination with other preventive techniques.

Direct effects on rangeland vegetation are more closely associated with the site preparation methods previously discussed. Indirect effects to range ecosystems are associated with changes in habitat suitability, and in the quality and quantity of available forage.

Seeding of grass and legumes increases the quantity and quality of forage (Rhodes and Sharrow,1983; Sharrow and Leninger,1983). The indirect effect of this technique is a potential increase in carrying capacity.

On transitory range (conifer plantations), these effects may last 10 to 20 years depending on conifer stocking levels and site productivity. Seeding of grasses, legumes and forbs will increase the length of time that conifer plantations can provide suitable vegetation for livestock. This is a result of delayed invasion and dominance of a site by shrubs and trees (Klingler,1986).

The potential for indirect or cumulative effects of seeding activities to adversely impact range ecosystems is low. Generally, vegetation diversity and distribution should increase with seeding activities.

Grazing of Domestic Livestock

The use of domestic livestock grazing as a vegetation management technique has potential direct, indirect, and cumulative effects. For the purposes of vegetation management, grazing is used to manipulate vegetation for the release of a desired plant species (typically conifers). There are few examples of livestock grazing for purposes other than the production of red meat.

Most of the comments here are directed to the use of livestock on rangeland vegetation. The magnitude of these effects depends on the objectives, extent, and control of the grazing activities.

Potential direct effects of livestock grazing must be assessed at the project area level. A direct effect may be changes in ecosystem suitability of rangeland plant species. Overgrazing and poor distribution of livestock may lead to damage of more fragile vegetative components of the ecosystem, such as riparian zones. This can also directly affect wildlife use of an area which may in turn put more pressure on rangeland vegetation where preferred forage species are shared by livestock and wildlife.

Grazing pressure by livestock on critical big game range may cause wildlife displacement from key habitat components (traditional elk calving or deer fawning sites, wallows, water sources, etc.) during specific times of year.

Grazing activities that are properly timed and controlled have potential habitat improvement benefits. These include keeping vegetation in a succulent, highly digestible condition further into the summer; maintaining browse species at heights accessible to wildlife; and improving the quality of forage on winter range. Mitigating measures that minimize the potential impact to wildlife species are listed in Chapter II.

Conclusion

Biological, cultural, and grazing methods would be used on less than 1 percent of the acres. Alternatives A and D propose the greatest use (most acres) of biological, cultural, and grazing methods. All other alternatives reduce the use of these methods; Alternative C proposes the fewest acres of biological, cultural, and grazing methods.

Chemical Methods

Potential Direct Effects

Chemical herbicides have the potential for direct effects on rangeland vegetation, as well as on livestock. Changes in plant species composition and distribution can be directly affected by the use of herbicides

Toxic effects can occur to livestock as a function of both the inherent toxicity of a substance and the amount of exposure. Livestock can be exposed to herbicides by being sprayed directly, or by coming in contact with vegetation, other animals, soil, or water that has been contaminated. Inhalation of herbicides can occur from breathing in spray mist droplets or evaporative vapors.

Ingestion can occur if the animals drink water contaminated by herbicide, feed on treated vegetation or other animals that may have been contaminated, or if they eat the herbicide directly (for example, those herbicides which are applied in granular form). In addition, as animals clean themselves, they may ingest contaminated residues and hair.

Direct effects of herbicide use may be the immediate loss of a vegetative food source that has been sprayed. Livestock could be forced to find other sources of forage (direct loss of food) and cover, and may thus expose themselves to additional predation (indirectly increasing exposure).

Potential Indirect Effects

Habitat alteration effects can influence the numbers and kinds of livestock which can use an area. Treated vegetation provides food and cover for livestock.

Loss of or change in vegetation diversity may result in subtle range ecosystem changes and may influence the loss of species or the replacement of plants by more competitive species. Vegetation losses can affect wildlife species which contribute to the overall integrity of the range ecosystem. These changes ultimately affect the carrying capacity, which is the ability of rangeland vegetation to provide forage needed to support numbers of wildlife and livestock species.

Herbicides used to control or eliminate noxious weeds or less palatable species can result in improved forage quality, as long as the residual stand contains a high enough density of grasses and forbs to establish the site. Additional seeding may be required to assure this.

The use of broad spectrum herbicides which affect many plant species will obviously affect many more rangeland vegetation species than will the use of species-specific herbicides. Both herbicides used to control grass species and nonselective herbicides may have adverse impacts on available forage within the project area. The primary reason is that herbicide application will not displace livestock or wildlife populations from the treatment area, but will reduce the preferred food resources of these species. Establishment of grasses and annual forbs will increase both forage quantity and quality in following years.

Potential Cumulative Effects

Cumulative effects may occur when herbicides persist in the environment, particularly in vegetation, soil, and water containing residual amounts. They may also occur in project areas where multiple treatments are made over a period of time. The potential for an accumulation of herbicides in the body tissues of livestock is very slight.

Limited research and monitoring has been done to examine the effects of chemical herbicides on soil microorganisms and terrestrial invertebrates that make up portions of the food chain. Subtle effects on vegetation diversity and growth (with subsequent effects on range ecosystems) may also occur if nutrient cycling performed by soil microorganisms is interrupted.

Herbicides persist for variable amounts of time in soil and/or water (see soil and water sections, this chapter). Environmental conditions, the timing of applications to rainfall, soil structure, adsorption, solubility, and mobility all affect the persistence of herbicides. Site-specific project analysis must be completed to gain a better idea of the potential short- and long-term effects on rangeland vegetation and the integrity of range ecosystems.

Conclusion

Of all the methods proposed for use, herbicide application provides the least opportunity for post-treatment habitat improvement activities. Effects to smaller, invertebrate wildlife and microorganisms that contribute to food chains and nutrient cycling in range ecosystems are not known.

Site-specific project analysis should identify opportunities and problems of herbicide use related to the rangeland vegetation resource in the choice of the herbicide formulation, the method of application,

the timing of application, and the environmental characteristics of the site which influence the fate of the herbicide.

Approximately two-thirds of the acres treated for range improvement would be treated using herbicides under most alternatives. Alternative G will treat the most acres with herbicides, followed in decreasing order by Alternatives F, B, H, E, and D. Alternatives A and C do not allow the use of herbicides The potential for effects to rangeland vegetation increases as the amount of acres treated increases and as the potential for corrective as well as preventive treatments increase.

Treatment Summary

Potential adverse effects on rangeland vegetation for each alternative are associated with the differences in acreage treated, not with the method.

The direct effect of treatment is an increase in forage on the grass and shrub/bunchgrass range types. On forest/bunchgrass, shrub/bunchgrass, and transitory range, the effect is an increase in the land available for forage production and an increase in available forage. Indirectly, the amount of forage available affects the number of animals an area can support and the amount of red meat production.

Under Alternatives B, E, F, G, and H, approximately the same number of of acres (16,000) are treated. Under Alternatives C, A, and D (respectively), 0, 6,000, and 9,000 acres are treated. Thus, some relative reduction in land and forage availability could be expected under the latter three alternatives.

Noxious Weeds

The noxious weed program is designed to prevent the adverse effects of noxious weeds on animals (usually domestic livestock), and to a lesser extent, on native plant and wildlife habitats, and the human population. This section was expanded considerably in response to public comments on the draft EIS. See Appendix I for details. Previous control strategies have promarily concentrated on established infestations, and not the prevention of new invaders.

Adverse effects can result from allowing noxious weeds to spread. Poisonous species may disable or kill livestock, wildlife, and occasion-

ally people (refer to the program descriptions in Appendix G). The majority of poisonous plants (11 of the 16 species that appear on state noxious weed lists) are native species. Site-specific project plans need to consider control programs that deal with these plants over large acreages, rather than simply spot treatments. This will avoid conflicts with other resource programs.

The displacement of native plants and degradation of habitat can have serious long-term effects. Failure to control noxious weeds on National Forest system lands can allow an infestation to spread to adjacent lands—federal, state, and private. Severe economic losses can occur on agricultural croplands infested with noxious weeds.

Coordinated efforts for noxious weed control programs are essential for effecive, cost efficient, and consistent results. State goals closely parallel Forest Service objectives. Similar cooperation in adjacent Regions and states has resulted in integrated weed management plans that emphasize long range strategies, education, prevention, and treatment priorities.

Three categories are commonly recognized to establish a uniform method to address noxious weed infestations, both established infestations and those which have the potential to become established:

Category 1. Potential New Invaders: Emphasis on education, awareness and prevention of noxious weed species that do not yet exist on National Forest System lands. Continuing education and awareness program is conducted to train Forest Service personnel and public land users to recognize Category 1 noxious weeds. Information concerning their respective noxious weed control treatment programs and established priorities is shared with state and county weed control agencies. Once a Category 1 weed is identified as having invaded an area, it would be placed in Category 2 and the appropriate action would be taken, as described in Category 2.

Category 2. Eradication of New Invaders: The highest priority in treatment is given to new invading noxious weeds in a specific area. The strategy is to collect or control 100 percent of the seed production from the noxious weed species. A key factor is to prevent conditions that allow them to become established. Eradication is the goal for weeds in this category. The new invaders should normally receive the highest priority in funding and control efforts. Appropriate isolation and eradication measures should take place immediately to prevent the species from going to seed. Coordinate surveys with adjacent landowners to identify all infestations, the cause of the infestation, and reduce the possibilities of a re-entry.

Category 3. Established Infestations: Weed species in this categoy have become so established and widespread in distribution that for all practical purposes, eradication would not be feasible. The goal is containment and suppression to prevent a further spread of the infestation. Special consideration should be given to "breakouts" from existing infestations, using methods that consider the practicality, cost effectiveness, and likelihood of success. Management practices would be used in conjunction with control activities, which may include promoting vegetation to better compete with noxious weeds, regulating the movement or use of domestic livestock, and regulating the movement or use of vehicles.

Usually, range and wildlife habitat improvement projects are coordinated with noxious weed control efforts. See the discussions of range and wildlife in other sections of this chapter.

Administration of this program can have effects on the environmental components discussed in this EIS. However, treatment of noxious weeds is not expected to seriously affect these components, in part because of the comparatively small acreage involved. (Regionally, this varies from 4,000 to 10,000 acres among the alternatives, except for Alternative C.) In addition, the biological agents used to suppress noxious weeds (usually insects or their larvae) are "species-specific", that is, they act only on the target species

Herbicides would be used on about one-quarter of the acres treated, except under Alternatives A, C, and G. Alternative A does not allow the use of herbicides and C is the no action alternative. In Alternative G, herbicides are used two-thirds of the time.

Conclusion

Alternative C, in which no action is taken, would adversely affect the efforts to curb the spread of noxious weeds, and there is also the potential to result in higher mortality of livestock and a reduction in the amount of usable range. It would substantially detract from the efforts of cooperating agencies to control noxious weeds.

Diversity

Diversity is popularly thought of as the number of different species in a defined area. However, more precise definitions often include measures of the relative abundance of each species, and their distribution over time and space. This broader, more precise view could be used to assess population trends and some aspects of animal habitat.

Potential Direct Effects. The potential direct effects of vegetation management on diversity are changes in the amount of plant cover; the number of individuals; the number of different species (species composition); the age class distribution (the relative number of old and young species and their life span); and the structural characteristics (the height and the distribution of plants).

Of these possible effects, the most sensitive to changes in diversity is the number of different species, or species composition.

Potential Indirect Effects. The most important and immediate indirect effects of change in vegetation are on wildlife (for those effects, see the section on wildlife in this chapter).

The potential for effects on long-term site productivity as an indirect result of changes in diversity are not known. More long-term monitoring and research is needed. There is concern that a reduction in brush cover could result in lower carbon input into the soil over time. Other concerns are the reduction of cover and the shortening of the life cycle of nitrogen-fixing plants.

General requirements for the maintenance of natural diversity are given in the Code of Federal Regulations 36 CFR 219.27 (a), (b), and (g). Although no specific index is given, the intent is to maintain populations of natural plants over the landscape. The standards and guidelines listed in Chapter II in the methods section, and the specific Forest standards and guidelines listed in the planning documents will be applied. Thus, effects on vegetation diversity are expected to be minimal.

Effects on Diversity

Consistent with regulations and the Standards and Guidelines, most methods of vegetation management are not intended to eradicate vegetation, except in the noxious weed program (see preceding section). The intent is to change the dominance of species to favor the crop tree (or other preferred) species by reducing the amount of

competing vegetation. Consequently, the most consistent effect on vegetation is a reduction in cover of the target species.

Alternative A has the greatest potential effect on diversity. Approximately 185,000 acres are expected to be treated mechanically, and 218,000 acres treated thermally. Chemicals are not used. Mechanical methods and prescribed fire have the greatest effect on diversity because they are the most difficult to control (see the appendix on efficacy). For example, plants can be removed with the roots, indiscriminately, by a brush blade when scalping. However, a majority of the acres treated mechanically are on the East-side, where slopes are not steep and treatment can be controlled.

Broadcast burning is also very non-selective. Fire does have the potential to enhance diversity by keeping fire-dependent species healthy, however. (See the discussions on fire in Chapters III and IV.)

A relatively high number of acres are treated with fire in Alternative B (210,000 acres) and Alternative G (215,000 acres). Alternative H would treat approximately 205,000 acres. The effects on cover and diversity depend on how well local and Regional mitigation measures are followed.

Alternative C treats the lowest total number of acres; the only vegetation management done under this alternative is that needed to provide for public safety. Fire is not used, thus the potential for adverse effects on diversity directly resulting from vegetation management is reduced. Over the long term, however, the probability of more severe, extensive wildfire is increased (see the section on wildfire in this chapter).

Severe wildfires could potentially have more serious adverse effects on diversity than prescribed fire or mechanical methods of vegetation management.

Potential Cumulative Effects

Plant population numbers could be increasingly reduced if successive activities were too frequent to allow revegetation of plants removed from the site.

Changes in age class distribution can result when the crop trees shorten the age span of shade-intolerant brush by effectively reducing the amount of sunlight reaching the understory.

Conclusions

Since total removal of the plant has the most serious adverse effects on plant diversity, mechanical methods (such as scalping) have the

highest potential for adverse effects. Small concentrations of a population may be removed during the most intensive operations. Normally, that is not a serious problem, but the effect on the total population is adverse if the plant is rare, or if the only remaining concentrations are too far removed to re-establish themselves. Locally, diversity will have been reduced. Strict adherence to standards and guidelines and mitigation measures should prevent any adverse effects.

Threatened, Endangered, and Sensitive Animal and Plant Species

The Endangered Species Act of 1973, as amended, requires that all Federal agencies seek to conserve threatened and endangered species. They are required to consult with the Secretary of the Interior to assure that any actions they take are not likely to jeopardize the continued existence of any threatened or endangered species, or to result in the destruction or adverse modification of designated critical habitat.

Reviewers commented that the draft EIS did not make it clear that we complied with "Section 7 consultation" requirements. During the process of this "Section 7 consultation" for this EIS, the Fish and Wildlife Service concurred with our determination that the proposed action (as outlined) would have no effect on federally-listed species.

This conclusion is based on the fact that site-specific evaluations would be conducted at the National Forest level. If a "may affect" determination is made on any specific project, the Forest Service would initiate additional Section 7 consultation procedures at that level.

Discussion

Populations of animals can experience adverse impacts through direct site disturbance. They may also be affected indirectly by a shift in the vegetation composition of an area that would favor more competitive or invasive species. Thus, it is imperative that all project level assessments include surveys to determine the presence of plants listed on the Regional Forester's Sensitive Species List. (This list is available from the Regional Office upon request.)

The evaluations will include a review of existing recovery plans to determine the compatibility of proposed activities with recovery and/or protection objectives.

Vegetation management activities can benefit sensitive animal species. They are often proposed in recovery plans to improve habitat suitability. The techniques used, timing of the activity, and intensity of treatment will vary by site and species. Thus the direct, indirect, and cumulative effects of these activities must and will be documented in project-specific biological evaluations.

Identification of any threatened or endangered plant species within a project area will be followed by consultation with the U.S. Fish and Wildlife Service. The Oregon Natural Heritage Program and the Washington Natural Heritage Program will be used as informal cooperators involving sensitive plant species. Protocols for proceeding with biological evaluations are specified in Forest Service Manual 2600.

Following these protocols will minimize the potential for any adverse consequences in all alternatives.

In summary, no action will be taken under any of the alternatives being considered that would adversely affect the recovery of any threatened or endangered species.

Effects on Wildlife

Introduction

Vegetation management activities and the techniques employed have varying effects on wildlife and their habitats.

These effects vary according to factors such as the method used; characteristics of the site where the treatment is applied; timing and intensity of treatment; the size and distribution of the treatment areas; and the sensitivity of the plant or wildlife species occurring within the project area.

The Region's vegetation management programs tend to concentrate activities in early successional stages of plant growth. This concentration influences the numbers and kinds of wildlife affected by selecting those wildlife which tend to use all or a portion of these early successional plant stages as a component of their habitat.



Different vegetation management activities and the techniques used have varying effects on wildlife populations and habitats. The magnitude of these effects can be determined only by assessing predicted changes at the project site.

Six broad vegetation complexes are detailed in Appendix A to present a cross-section of conditions in the Region, primarily directed to acres which are designated as full yield timber acres. These vegetative strata represent 55 percent of the intensively managed "suitable" timberlands in the Region:

A. Douglas-fir/alder

B. Douglas-fir-hemlock/salmonberry/herbaceous

C. Ponderosa pine/grasses-herbaceous

D. Douglas-fir-ponderosa pine/Ceanothus spp./herbaceous

E. Douglas-fir/tanoak/madrone

F. True fir-hemlock/shrub/herbaceous

Of the vertebrate terrestrial wildlife species commonly found within the Region, 129 species (amphibians, reptiles, birds, and mammals) can be linked to grass/forb stand conditions of these broad vegetation types. These species are those whose feeding habits use grass/forb conditions as either primary or secondary habitat within the six broad forest types. Appendix J-a has a complete listing of the species and use.

Each method of vegetation management affects wildlife directly by effects on individual animals (death or displacement), and indirectly through changes in habitat suitability. Impacts such as habitat disruption, microclimate alteration, elimination of nutrient sources, and differential pressure on prey and predators may contribute to effects

on wildlife populations. The impacts can be immediate, delayed, short- or long-term, synergistic, or cumulative. Combinations of two or more of these impacts are also possible.

Both direct and indirect effects may be important to the extent that they lead to changes in the numbers and kinds of wildlife. Cumulative effects may occur as a result of combining treatments within a project area; repeating treatments while the effects of previous treatments (changes in vegetation, compacted soil, chemical residues) are still present; and treating different areas within the same project area over a period of time.

Individual species, as well as groups of wildlife species, respond differently to vegetation manipulation. Activities that benefit some wildlife are likely to be detrimental to others. For example, a study of small mammal populations at sites treated with herbicides in Oregon (Perry et al.,1985) showed that some species (deer mouse and Towbridge shrew) increased, while others (Oregon vole, jumping mouse, and vagrant shrew) declined. Treatments evaluated in this study shifted vegetation dominance from grasses to shrubs, altering both food sources and cover for the small mammals. With any vegetation management activity, at any site, some wildlife populations will increase while others will decline.

Another study of an herbicide-treated Jeffrey pine plantation in California (Savidge,1978) reported no effect of the treatment on bird populations two years after the application. By the time six years had passed, the treated vegetation on the sites (ceanothus and manzanita) had collapsed and was failing to provide nesting cover. The population of resident birds (numbers of individuals as well as species) had been substantially reduced.

The effect and magnitude of these changes on wildlife populations can be determined best by assessing predicted changes at the project site in relationship to the surrounding landscape. The cumulative effects of projects can then be better evaluated for combinations of treatments or methods.

For example, a range improvement project converting an area dominated by sagebrush to one dominated by grasses and forbs could increase wildlife diversity in a landscape of extensive sagebrush stands. If the treatment reduced the only sagebrush existing in the vicinity, however, the effect would be to reduce wildlife diversity. If the treatments were planned for annual implementation to cover a larger

project area, the effects could be cumulative and also reduce wildlife diversity.

Vegetation management creates opportunities for improving wildlife habitat as well as creating risks of adverse effects on habitat. The more intensively vegetation is managed, the greater are both risks and opportunities. The risk of adverse impacts of vegetation management on wildlife and wildlife habitat can be minimized by the following means:

- controlling the size, distribution, and number of proposed treatment areas (on a drainage or other geographic basis);
- controlling the selectivity of treatment (through choice of method or the intensity of application) to influence changes in structure and composition of vegetation, and thus of wildlife habitat; or
- controlling the timing of application or treatment to reduce effects on a wildlife species or groups of species. (For example, spring burning is likely to have greater adverse effects on nesting birds than does fall burning, but it may lead to greater growth of forage for herbivorous species.)

Actual specific project requirements and mitigation measures will depend on site-specific analysis of potential effects and consequences, and on development of wildlife objectives in coordination with other resource management programs and agencies.

Manual Methods

Potential Direct and Indirect Effects

Manual techniques have the lowest potential for direct effects on wildlife. These techniques have minimal influence on habitat components other than vegetation, and can be selectively applied. The effects of these methods are therefore generally limited to indirect or cumulative effects associated with habitat alteration.

Effects can be controlled to manipulate plant species composition, structure, and successional patterns on a project site. These changes may be used to maintain, enhance, or diminish wildlife populations in the area.

Cumulative Effects

A combination of manual treatments within a project area may have cumulative effects related to the distribution and diversity of plant communities and successional stages. This will cause subsequent changes in an area's wildlife populations.

Conclusion

Alternative C provides for the highest proportion of manual methods (20 percent) relative to the other techniques available. Under Alternative A, the highest number of acres would be treated manually. In descending order, decreasing numbers of acres would be treated in Alternatives E, G, F, H, B, D, and C. The potential for impact to wildlife populations is proportional to the amount of acres proposed for treatment.

Mechanical Methods

Potential Direct and Indirect Effects

Mechanical methods have the greatest potential for direct effects on soil-dwelling animals such as ground squirrels, pocket gophers and salamanders. When treatments occur in the spring, species such as ground-nesting birds may also be affected. Direct effects are generally limited to the time when activities take place, but may last longer if soils are compacted.

Down trees and slash provide important habitat for small mammals, birds, reptiles, amphibians, insects, and other invertebrates. Removal of this woody material could result in direct reductions in populations of these species. It could also indirectly affect predator or prey populations by reducing their food sources. The cumulative effect could be a reduction in wildlife populations over a large area.

For larger wildlife, such as deer and elk, logging slash or natural accumulations of woody debris can impair access, reducing their use of an area. Removal or strategic placement of some of this material can improve habitat quality for these animals.

Exposure of mineral soil during mechanical treatments can encourage invasion of plant species adapted to germination on such sites. These species are often undesired brush or tree species (rabbitbrush or red alder, for example). Sites with bare mineral soil are the most susceptible to invasion by noxious weeds. Growth of these species generally degrades wildlife habitat.

Mechanical treatments also provide opportunities to improve wildlife habitat by providing a good seed bed for establishing high-quality grass and legume forage mixes or preferred browse species.

Cumulative Effects

As with manual treatments, a combination of mechanical treatments may have cumulative effects related to the distribution and diversity of plant communities and successional stages. This will cause subsequent changes in an area's wildlife populations.

Conclusion

The greatest potential for important long-term effects of mechanical methods on wildlife populations would result from soil compaction or loss of site productivity. Mitigation measures for mechanical methods (described in Chapter II and discussed in the soils section in this chapter) will be important in limiting adverse effects on wildlife populations.

Alternatives A, B, E, F, G, and H would involve similar levels of mechanical methods and would have similar potential for effects on wildlife. Alternative D would treat 36 percent less area with these methods, with a corresponding reduction in effects. Alternative C would reduce use of mechanical methods by 80 percent.

In general, the fewer acres treated with mechanical methods in a given alternative, the less risk there is to wildlife populations. However, there is also a corresponding loss of opportunity to implement post-treatment habitat improvement activities in those alternatives that limit the use of mechanical methods.

Prescribed Burning

Potential Direct and Indirect Effects

Those who have studied the effects of fire on wildlife do not generally consider prescribed fire to pose a serious threat (Lyon and Marzluff,1984; Starkey,1985; Brown,1985). While there has been relatively little research to evaluate the direct impact of fire on wildlife (Starkey,1985), a number of studies have shown that most species of birds and mammals remain after forest fires (Bendell,1974 in Starkey,1985). Larger and more mobile species can readily flee most fires, and small animals need only retreat a small distance under ground in order to survive.

Variations in the timing and intensity of fire modify its effects on wildlife habitat. Prescribed burning plans need to provide for protection and maintenance of large fallen logs and snags. These are important habitat components that can be lost through improper control of fire and fire crews. As with mechanical methods, fire can be used to reduce accumulations of slash, improving access for some animals.

Burning can stimulate the growth of plants eaten by wildlife, and has been shown to improve the palatability of forage for big game (Yoakum et al.,1980). Forage improvement activities are highly dependent on prescribed burning for preparation of a seedbed. This is particularly important in areas where soils, topography, or slope limit the use of mechanical methods for preparing a seedbed.

Where fuel accumulations have increased during long periods of fire suppression, animals may not be able to escape or avoid catastrophic fires. Significant numbers of animal kills have been reported for chaparral wildfires in California (Starkey,1985).

High intensity wildfires have different effects than most prescribed fires, which typically result in a mosaic of burned and unburned vegetation. These mosaics contribute to habitat diversity. Unburned patches allow maintenance of populations of some species with narrow ecological niches, such as shrews (Starkey,1985).

Cumulative Effects

As with manual treatments, a combination of prescribed fire treatments may have cumulative effects related to the distribution and diversity of plant communities and successional stages.

The amount of control that can be applied to treatment areas is less than that of manual and mechanical methods. Compared to manual and mechanical methods, use of prescribed fire can result in relatively long-term changes in stand conditions. These may also occur over larger areas of land in a much shorter period of time compared to the other methods. Consequently, there is more risk if prescribed fire is used without site-specific considerations.

While the use of prescribed fire can have more risk than manual and mechanical methods, it also has some significant advantages. Many vegetation types are closely linked in their development to the influences of natural fire.

Fire prescriptions that are designed to mimic natural fire occurrences combined with the control of how, when, and where the prescribed fire is used can provide effective wildlife habitat improvement for forage conditions. Soil and water values (that might be damaged under the conditions of a hot-burning, uncontrolled wildfire) can be protected if prescribed fire is conducted in a way that controls those burning conditions.

The use of fire to create more of the "edge effect" is unparalleled by any other treatment method. The edge effect is the increased richness of flora and fauna occurring in the transition zone where two plant communities or successional stages meet and mix.

Treatment of large areas with prescribed fire (or treatment of a combination of small prescribed fire units close together) can result in relatively long-term changes in vegetative condition. This will cause subsequent changes in an area's wildlife populations.

Conclusion

The effects of fire on invertebrates (which form an important part of the diet for many amphibians, reptiles, birds, and mammals) are not well understood (Komarek,1984). Similarly, little is known about the effects on wildlife populations of by-products of fire such as polynuclear aromatic hydrocarbons which can cause cancer, and which have the potential for accumulating in the bodies of wildlife exposed to them (Perry et al.,1985).

Prescribed burning is used at similar levels in Alternatives A, B, G, and H. Alternatives E, F, and D would treat fewer acres with fire, and Alternative C would make no use of this method for vegetation management.

The substantially increased potential for catastrophic wildfires which is predicted as a result of implementing Alternative C would increase the potential for direct adverse effects on wildlife populations. Habitat improvement opportunities are highest in the alternatives which increase the use of prescribed fire, and decrease proportionally as the use of fire is restricted.

Potential Direct, Indirect, and Cumulative Effects

Biological, Cultural, and Grazing Methods

The use of these three techniques for vegetation management has little potential to directly affect wildlife populations. The potential for indirect and cumulative effects is greater, but it varies with the technique used.

Utilization of predators, pathogens, and parasites as natural enemies for the control of certain introduced noxious weeds is the main emphasis of biological control methods. Because they are introduced, the noxious weeds are virtually free of natural enemies. Thus, biological control agents that evolved in the same ecosystem as the target (host) plant can be used to selectively control individual species of noxious weeds. This is possible only because of the "host-specificity" of these agents, which are attracted only to the species with which they evolved.

The majority of cultural control methods used involve seeding with grasses and legumes, forbs, and shrub species.

Prolonged or forced grazing of domestic livestock is used to control the composition or amount of competing vegetation.

Biological Methods

Natural predators, pathogens, and parasites are used primarily for managing noxious weed populations. The release and establishment of

these agents for biological control has a very low potential to adversely affect wildlife either through direct or indirect means. The agents released for noxious weed control are species-specific and are natural enemies of the weeds.

Before the agents are released for this purpose, the effects of using them are thoroughly studied and evaluated. Generally, the process involves identifying the area and natural ecosystem of the target plant. Much of the research is conducted in Europe and Asia where many of the plants are native species. The species is monitored to determine natural enemies that help to control its growth and dispersal. These natural enemies are then studied to assure that they are very specific ("species-specific") in their preferences.

If the agent appears to be suitable, USDA approval must be granted before entry into the US is allowed. Since 1940, when biological control agents were first introduced for noxious weed control, no harm related to their introduction has been documented.

Presently, 21 species of noxious weeds are targeted for control in the Pacific Northwest. It takes an average of three to five years for the biological control agents to become established at selected sites, although their efficacy increases over time. While acres of land may still be considered to be "affected" by the noxious weed, the control agents have reduced infestations below economic injury and threshold levels.

Plants targeted for control are usually non-native, toxic to many wildlife species, or may compete with preferred forage plants. Wildlife species may, in some cases, actually slow the establishment of the biological control agent by utilizing them as a food source.

Seeding and Planting

Successful seeding of grasses, legumes, and forbs or planting of shrubs depends on preparation of an adequate seedbed. The most common methods are mechanical site preparation and prescribed burning. The effects of these methods were previously discussed in this section. Seeding is generally used in combination with other preventive techniques. Planting of desirable shrub species can be done in combination with manual techniques.

Direct effects to wildlife and wildlife habitat are more closely associated with the site preparation methods previously discussed. Indirect effects to wildlife populations are associated with changes in habitat suitability, and the changes in the quality and quantity of available forage.

Seeding of grasses and legumes increases the quantity and quality of forage (Rhodes and Sharrow,1983; Sharrow and Leninger,1983). The indirect effect of this technique is a potential increase in carrying capacity, and a potential increase in deer and elk reproductive rates (Mackie and Kistner,1985).

On transitory range (conifer plantations), these effects may last for 10 to 20 years, depending on conifer stocking levels and site productivity. Seeding of grasses, legumes and forbs will increase the length of time that conifer plantations provide suitable habitat for those species dependent on (or preferring) early seral stages. This is a result of delayed invasion and dominance of a site by shrubs and trees (Klingler,1986).

The potential for indirect or cumulative effects of seeding activities to adversely impact wildlife is low. In general, wildlife diversity and population levels should increase with seeding activities.

Grazing of Domestic Livestock

Domestic livestock grazing has potential direct, indirect, and cumulative effects on wildlife. The magnitude of these effects depends on the objectives, extent, and control of the grazing activities.

Potential direct effects of livestock grazing must be assessed at the project area level. These potential effects include displacement of resident big game; transfer and spread of parasites and disease; and impacts of predator control measures that may be implemented to protect domestic animals.

Indirect effects that may have impacts on wildlife include changes in habitat suitability; competition for forage on summer and winter range; and displacement from critical habitat (such as traditional elk calving or deer fawning sites, wallows, water sources, etc.) during specific times of year.

Grazing activities that are properly timed and controlled have potential habitat improvement benefits. These include keeping vegetation in a succulent, highly digestible condition further into the summer; maintaining browse species at heights accessible to wildlife; and improving the quality of forage on winter range. Mitigating measures that minimize the potential impact to wildlife species are listed in Chapter II.

Conclusion

Alternatives A and D propose the greatest use of biological, cultural, and domestic grazing methods and therefore, the highest num-

ber of acres that would be treated using these techniques. All other alternatives reduce the use of these methods; Alternative C proposes the fewest acres of biological, cultural, and grazing methods.

Herbicide Methods

Potential Direct Effects

Chemical herbicides have the potential for direct toxic effects on wildlife. Toxic effects can occur as a function of both the inherent toxicity of a substance and the amount of the substance to which an animal is exposed. Wildlife exposure to herbicides can occur from being sprayed directly, or by coming in contact with vegetation, other animals, soil, and water that has been contaminated.

Inhalation of herbicides can occur from breathing in spray mist droplets or vapors.

Ingestion can occur from drinking water contaminated by the herbicide, feeding on treated vegetation or other animals that may have been contaminated, or eating the chemical directly if it is applied in a granular form. Contact can also occur through cleaning and preening functions where contaminated residues, hair, or feathers are ingested.

Other direct effects may be related to the immediate loss of a vegetative food source that has been sprayed. Individuals of a wildlife population would be directly affected by loss of food, forcing them to find other sources of forage. This may indirectly increase their exposure to additional predation.

Potential Indirect Effects

Habitat alteration can affect the numbers and kinds of wildlife that use an area. Treated vegetation provides food, cover, and nesting materials for some wildlife species.

Loss or change in vegetation diversity may result in subtle wildlife diversity changes. For example, while treated brush species may be defoliated immediately, directly affecting wildlife species that use it for forage, the woody stems may continue to provide nesting cover for a period of time until they begin to break down or decompose. At this time, a delayed effect to those wildlife species occurs.

Herbicides used to control or eliminate noxious weeds or less palatable species can result in improved forage quality, as long as the residual stand contains a high enough density of grasses and forbs to establish the site. Additional seeding may be required to assure this.

The use of broad spectrum herbicides that affect many plant species will obviously affect many more wildlife species than an

herbicide that is species-specific. Herbicides used to control grass species (or nonselective herbicides) may have adverse impacts on available forage within the project area.

In the case of aerial conifer release, browse damage from deer, elk, rabbits, hares, and mountain beaver will increase. The primary reason is that herbicide application will not displace these populations from the treatment area, but will reduce the preferred food resources of these species. The conifer seedlings then become a more desirable forage species, relative to the other remaining plants available.

Browse damage risks will be greatest for conifer seedlings less than 30 inches tall during the year of treatment. Resprouting of brush and establishment of grasses and annual forbs will increase the forage quantity and quality in subsequent years.

An herbicide chosen for vegetation control because of its long-lasting effects will have implications for those wildlife species using that habitat and food source. If a particular plant species, or group of plant species, is suppressed (or eliminated) for a lengthy period of time, the effects will also be displayed in the wildlife population.

Potential Cumulative Effects

Cumulative effects may occur when herbicides persist in the environment, particularly in vegetation, soil, and water containing residual amounts.

Combinations of direct and indirect effects influence the types and duration of exposures. Highly mobile or migratory species may be most at risk because they can easily move from one treatment area to another. Therefore, these species are more likely to have several exposures within a given year or over a period of years.

Limited research and monitoring has been done to examine the effects of chemical herbicides on soil micro-organisms and terrestrial invertebrates that make up portions of the food chain. Subtle effects on vegetation diversity and growth (with subsequent effects on wildlife) may result if nutrient cycling performed by the soil micro-organisms is interrupted by herbicides.

Sublethal effects of herbicide contact may occur for individuals of a wildlife species or for a population as a whole. These effects are not well-documented or understood because of the time period involved in monitoring for these effects.

If such effects lead to an animal's inability to avoid predation (due to gradual impairment of motor responses), or slowly decrease the

numbers of smolt fry (due to an inability to absorb their yolk sacs), then the overall result could parallel the effects of high direct toxicity.

Wildlife Risk

For the herbicides under consideration in this EIS, laboratory studies generally indicate relatively low toxicity to laboratory animals. The amount of research and data for specific wildlife species is minimal. Extrapolation from laboratory animals to wildlife involves broad assumptions and considerable variation in estimates of effects.

In trying to compare laboratory animals to wildlife species these are some of the difficulties encountered:

Laboratory animal	vs	Wildlife species
1. Genetic background and/or strain information often known and controlled.		1. No genetic background available.
2. Chemical body burdens known.		2. Unknown.
3. Parasite/disease free.		3. Unknown.
4. Controlled environment.		4. Variable field conditions.
5. Food provided has content analysis known. Amount of food eaten is known.		5. Food content analysis unknown. Amounts eaten unknown. May follow feast and famine routine where fat reserves storing body burden chemicals are readily used.
6. Water provided has content analysis known. Water always available.		6. Water content analysis unknown. Supplies may fluctuate.
7. Predation not a factor. Stress controlled.		7. Predation possible. Animal under some stress.
8. Amounts of chemical doses specifically known.		8. Amounts of chemical contact by direct and indirect means difficult to measure.
9. Effects of chemical can be monitored and assessed.		9. Difficult to monitor and assess.

The variables of monitoring herbicide effects on wildlife species under natural field conditions are enormous and difficult to predict, much less control. Extrapolation from laboratory research does help to establish a baseline, however, the limitations lead to great variation in estimates of effects.

Information needed to assess risk involves inventories and life histories of the wildlife species found in the proximity of the project site, the effects of the herbicide on target and nontarget plant species, and the environmental fate of the herbicide. These considerations are most appropriately dealt with during environmental analysis for site-specific projects.

Quantitative risk analyses have been conducted that estimate the levels of exposure of wild animals to herbicides, and which compare these exposures to levels shown to cause acute toxic effects in laboratory animals (Drug Enforcement Administration,1985; US Department of Interior, Bureau of Land Management,1986).

These analyses adopt the criteria established by the Environmental Protection Agency (1986), in which potential adverse effects are assumed to exist when estimated exposure levels exceed 1/5 of the LD50 or LC50*.

Similar quantitative analyses have been conducted by the EPA to assess risk to threatened and endangered species. For these species, the criteria applied are more stringent. Potential adverse effects are assumed to exist if estimated exposure exceeds 1/10 of the LD50 or LC50.

A review covering pesticides used in forestry applications (Serfis et al.,1986) included 11 of the herbicides considered in this EIS (amitrol, atrazine, dalapon, 2,4-D, 2,4-DP, fosamine ammonium, glyphosate, hexazinone, picloram, simazine, and tebuthiuron). None of these chemicals exceeded the criteria for mammalian or avian species. Virtually no information is available for the majority of invertebrate, amphibian, and reptilian wildlife species.

The toxicity information for the other five herbicides (asulam, bromacil, dicamba, diuron, and triclopyr), based on similar laboratory studies, is comparable to those covered in the EPA review.

These studies indicate that the herbicides being considered in this EIS are unlikely to have adverse effects on wildlife populations. How-

* LC50 is the lethal concentration rate at which 50 percent of the test animals will be killed. LD50 is the lethal dosage rate at which 50 percent of the test animals will be killed.

ever, the limitations of these analyses must be recognized. While nearly 600 vertebrate wildlife species inhabit National Forest lands in the Pacific Northwest Region, laboratory experiments to determine toxicity are conducted with only a few of these species.

Interspecies variation in sensitivity to chemical toxicity is considerable. In addition, registration testing has usually involved only tests on the active ingredient of the herbicide formulation and not the formulation that is typically used in the field for vegetation control.

The effects of the "inert" ingredients on wildlife has not been well researched or documented. (Inert ingredients are used in the formulations as surfactants, flow conditioners, emulsifiers, etc., and are protected from disclosure as proprietary information belonging to the herbicide manufacturer). The synergism of these chemicals with the active ingredient, or combinations of herbicide formulations and their effects on wildlife are other areas of concern.

These herbicides have variable persistence in soil and water (see soil and water sections, this chapter). Environmental conditions, timing of applications to rainfall, soil structure, adsorption, solubility, and mobility all affect the persistence of the herbicides. Site-specific project analysis must be completed to gain a better idea of the potential short- and long-term effects on wildlife.

Most of these herbicides are soluble in water (and not in fat), diminishing any tendency to accumulate in the bodies of animals exposed to them.

These factors have led many researchers to reach conclusions similar to those of Morrison and Meslow (1984), who wrote, "The extensive data on toxicity of herbicides to wildlife reveal that both acute and chronic [toxic] doses are well above levels found in the environment under normal field application rates. Furthermore, chronic doses are difficult to realize because of the low persistence of herbicides."

These views appear consistent with analyses conducted by the Forest Service (USDA Forest Service,1984b) and by the Environmental Protection Agency in development of registration standards. For the herbicides considered here, summary statements in these documents generally indicate at most low toxicity to wildlife.

In recognizing the research and data limitations for wildlife species, a review of herbicides and wildlife-oriented effects is contained in

Appendix J-b. A listing of herbicide formulations and inert ingredients of concern can be found in Appendix J-c. A literature review, with a particular emphasis on research involving the sixteen herbicides in relation to the wildlife species found in the Pacific Northwest, is presented in Appendix J-d.

Conclusion

The consequences of herbicide effects (toxicity) on wildlife species must generally be extrapolated from effects shown to laboratory animals. Effects to smaller, invertebrate wildlife and microorganisms that contribute to food chains and nutrient cycling are not known. Sublethal long term effects to wildlife have not been identified.

Site-specific project analysis should help to identify opportunities and problems of herbicide use related to the wildlife resource in the choice of the herbicide formulation, the method of application, the timing of application, and environmental characteristics of the site which influence the fate of the herbicide.

The highest number of acres treated with herbicides would occur under Alternative G, followed in descending order by Alternatives F, B, H, E, and D.

Alternatives A and C do not allow the use of herbicides The potential for effects to wildlife populations increases as the amount of acres treated increases and as the potential for corrective, as well as preventive, treatments increase.

Riparian Resources and Fisheries

Potential Direct and Indirect Effects

Vegetation management practices that disturb the vegetation, soil, or water of the riparian zone, or that cause increased sedimentation (see preceding discussions on soil and water resources) will trigger effects on aquatic systems and fish populations.

These effects may be the result of any method of vegetation management—manual, mechanical, biological or cultural methods, or prescribed burning. There are possible effects on fisheries resources which are unique to the use of herbicides these are also discussed in this section.

Increased erosion and sedimentation can inhibit fry (young fish) emergence (Tagart,1976), reduce fish feeding success, and cause channel aggradation (raising of the bed surface due to deposition). This can lead to loss of pool habitat (Cederholm et al.,1981).

Discussion

While the majority of fish spawning and rearing occurs in second- and third-order streams, the small first-order tributaries are of vital importance to the quality of downstream habitat (Sedell et al.,1981). These channels carry water, sediment, nutrients, and woody debris from the upper portions of the watershed to the larger streams.

First-order streams are the most vulnerable to impacts from mechanical methods and burning. However, Everest and Harr (1982) state that broadcast burning and machine piling seldom degrade water quality and fish habitat in small streams, due to the small area involved and the infrequent nature of these activities.

The mitigation measures developed to minimize erosion and sedimentation (see Chapter II) will also be effective in protecting fish habitat. Class IV (intermittent) streams transporting sediment to fish-bearing streams are potential sources of sediment. However, sedimentation due to roads constructed for timber harvest is likely to far outweigh the sediment produced by vegetation management activities (Sidle,1980).

Forest Service Manual direction (FSM 2526) and existing Forest land management planning documents call for protection of riparian areas. Vegetation management activities will not occur in riparian areas under any of the alternatives unless specifically prescribed for improvement of habitat.

Conclusion

None of the alternatives will result in substantial adverse effects on the fisheries resource due to alteration of the riparian area or from increased sedimentation due to vegetation management activities.

Effects Unique to Herbicide Use

Potential Direct and Indirect Effects

The likelihood of exposure of fish populations to toxic concentrations of herbicides used for vegetation management is low. If exposure were to occur due to drift from aerial applications, concentrations would be of short duration in flowing water. The potential for bioaccumulation or bioconcentration of any of the 16 herbicides considered in this EIS is low.

Discussion

For toxic effects to occur in a species, both exposure to a substance and exposure to a toxic concentration of it are needed.

In the forest aquatic environment, contamination is predominantly due to short-term acute exposures due to drift or accidental spill, rather than long-term chronic exposures (Norris et al.,1983).

Table IV-9 in the soils section of this chapter shows the relative toxicity of the 16 herbicides considered in this EIS. The table is based on the lowest concentration (reported in the literature) that kills 50 percent of the fish in a 96-hour period. (The term is thus the "96-hour LC50".)

Water quality factors such as temperature, hardness, salinity, oxygen and carbon dioxide content, and pH may affect fish response to herbicides in the laboratory and field (Lorz et al., 1979).

Bioaccumulation is the uptake and temporary storage of a chemical in animal flesh and organs. Bioconcentration is the increase in the concentration of a chemical within organisms as it moves up through the food chain. Both are most likely to occur when an organism is exposed to a persistent chemical of low water solubility and high lipid solubility. The herbicides reviewed for forest use in this EIS generally do not meet these criteria (Lorz et al., 1979).

The bioconcentration factor is the concentration in the fish divided by the concentration in water. Norris et al. (1983) lists the following bioconcentration factors for commonly used herbicides:

Herbicide	Bioconcentration Factor
2,4-D	13
glyphosate	3
atrazine	86
picloram	20

These chemicals are rapidly excreted as the concentration in water decreases due to dilution or degradation (Norris, 1980). By comparison, the bioconcentration factor for DDT is 22,500.

Laboratory studies may not show sublethal toxic effects such as effects on growth, behavior, reproduction, resistance to stress, migration, biochemistry, and physiology. These studies are often conducted on species of fish other than those found in the Region. In general, "cold-water" fish, such as trout and salmon, are more sensitive to herbicides and other pollutants than "warm-water" fish, such as bass and carp (Lorz et al., 1979). Juveniles and fry are typically more sensitive than adults.

Laboratory studies conducted on aquatic organisms often show toxic effects at 1/10 to 1/100 of the concentration reported for fish species. Therefore, while fish species may not suffer direct toxic effects, their food sources could be reduced or eliminated.

If toxic concentrations were to occur, it is possible that not all individuals in the aquatic system would be affected. Some individuals would leave the area or would exhibit greater tolerance to the herbicide (Norris et al.,1983). Repopulation of the area could occur through local survivors, migration, or hatching. With increasing distance downstream from the project, peak concentrations of herbicide residues would decrease, reducing the likelihood of ecosystem impact (Newton and Norgren, 1977).

The maximum concentration reported from monitoring within the Region in the period from 1980 to 1983 was 0.19 parts per million. As shown in Table IV-9 (in the soils section of this chapter), the majority of herbicides have 96-hour LC50 values (concentration which kills 50 percent of the test organisms in a 96-hour period) of greater than 10 parts per million.

Of the 235 samples collected in the Region during this four-year period, 203 had no detectable residue. See the discussion on water in this chapter for further discussion of monitoring results.

Effects of low concentrations of herbicides on fish and their food sources are difficult to study in the natural environment. It should be assumed, however, that sublethal effects may occur and that every effort will be made to mitigate these effects. The no-spray minimum buffer strip width (see the mitigation measures in Chapter II) will be expanded where necessary to protect the fisheries resource. Site-specific fisheries mitigation measures for herbicide and burning practices will be identified in the project Environmental Analysis Report and stipulated in the project plan.

Other mitigation measures that will be implemented (in addition to buffer strips on all live streams) will be measures to control drift; timing of projects to reduce risks of herbicide mobilization in ephemeral channels or overland flow; measures to reduce the chance of accidental spills; and monitoring to assure that these measures are effective.

According to Norris et al. (1983), unsprayed corridors along streams will prevent alteration of terrestrial ecosystems that influence aquatic ecosystems, and will also prevent changes in aquatic communities due to the use of herbicides.

Conclusion

Mitigation measures regulating the use of herbicides should prevent entry of biologically significant levels into surface waters. Short-term, acute concentrations may occur due to accidental spills or unpredicted weather conditions during or immediately after application.

Alternatives A and C (which prohibit the use of herbicides) will prevent exposure of fish to residues. The prohibition of aerial application under Alternative E will reduce contamination by direct application and drift, thus greatly reducing the risk of the occurrence of a substantial concentration of herbicides in water.

Alternative D allows the limited use of herbicides, with a low risk of contact with fish populations. An increasing number of acres is treated in Alternatives E, B, H, F, and G, with corresponding increases in the risk of impacts on fish populations.

Cumulative and Synergistic Effects

Potential cumulative and synergistic effects could stem from increased sedimentation, from change in the quantity and timing of flows, and/or from chemical contamination of surface waters due to combined activities in a watershed. See the preceding sections on soil and water for further discussion of these impacts.

Stream channels not confined by bedrock are shaped by their peak flows and sediment loads. A change in peak flows, summer base flows, and the sediment load in a stream could result in a loss of fish habitat (Brown,1974). Coats et al. (1985) found that significant filling of pools and burial of riffles by sand occurred during and after a peak flood in a California coastal stream.

Change in summer base flows, timing of peak flows, and sediment load could also adversely affect fish spawning and feeding. The changing flows can eliminate spawning sites or disrupt conditions of flow favorable for egg survival. Turbid waters can reduce fish feeding success (Norris et al.,1983).

However, effects on these aspects of channel hydrology due to vegetation management activities are minor compared to the effects of timber harvest (Osborn,1980) or road construction (Yee and Roelofs,1980). Cumulative effects analyses associated with these activities will consider impacts on fisheries resources as required by the National Environmental Policy Act.

Simultaneous exposure to more than one herbicide formulation is highly unlikely, because residues are rapidly degraded or diluted in aquatic systems, and repeated applications on an annual basis are rare (see soils, this chapter). Less than 0.2 percent of National Forest lands in the Region would receive treatment in any one year under any of the alternatives.

Mitigation measures designed to control direct application, drift, mobilization in ephemeral channels, surface runoff, and leaching will prevent exposure to toxic concentrations of herbicides. The properties of the herbicides used, as well as these precautions, will also prevent buildup of herbicides in aquatic environments between treatments.

Conclusion

Dispersion of activities within a watershed is the key to avoiding cumulative effects. Activities on lands in other ownership and effects of other activities on National Forest lands (such as road construction, timber harvest, and grazing) will be considered when planning projects under all of the alternatives.

Specific Lands and Areas

In environmental analysis, special attention is also given to potential effects on prime farmland, rangeland, and forest land; on wetlands and floodplains; and on urban quality and the built environment.

There are environmental effects of the alternatives on many aspects of forest and rangeland—these have been described throughout this chapter. There are no foreseeable effects on prime farmland.

Wetlands and floodplains will be protected by management to meet the requirements of Executive Orders 11988 and 11990. Mitigation measures to protect riparian areas and water are part of all alternatives (see Chapter II). These mitigation measures minimize or avoid the potential adverse impact of vegetation management activities, and no impact on wetlands or floodplains is foreseen.

Mitigation measures occasionally fail or are accidentally misapplied. The risk of this is slightly greater with the alternatives that would tend to manage vegetation aggressively with corrective strategies (Alternatives G, B, A, and F).

Urban quality could be influenced by variations in air quality. The management of vegetation around the built environment in recreation sites, administrative sites, and along rights-of-way varies by alternative. These environmental effects have been identified earlier in this chapter.

Insect and Disease Conditions

There are no measurable differences between alternatives A, B, D, E, F, G, and H in terms of effects on forest disease and insect populations. A general effect of all alternatives is that the conversion of existing wild stands to a regenerated or managed condition will reduce the severity of damage due to insects and pathogens. This is a reflection of the improved health and vigor of managed stands as density management principles are employed, and as over-mature or decadent stands are replaced.

Site preparation and release from competition are important steps in the sequence of events needed to bring about this conversion. Pest-

host interrelationships, however, can only be addressed on a site-specific basis and within the context of damage thresholds determined by management objectives. Alternative C (no vegetation management) would result in an increase in the frequency and severity of damage from insect and disease agents in comparison with other alternatives.

Land Uses

Because land ownership patterns vary extensively within Forest boundaries as well as adjacent to National Forests, implementation of a particular alternative could have significant effects on lands of other owners. These effects can be either positive or negative, depending on the use of the land and the perspective of the landowner.

Alternatives that restrict or eliminate prescribed fire (Alternatives C, E, F, and H) could have a positive effect on air quality (for a more detailed discussion on these effects, see Chapter IV sections on fire and air quality).

Alternatives that restrict or eliminate use of herbicides (Alternatives A, C, E, and H) have both positive and negative effects on other lands and landowners.

In those areas where active, aggressive programs to combat noxious weeds are in effect, non-use of herbicides by the Forest Service can have a detrimental effect on efforts to effectively control those weeds (see Chapter III, Noxious Weeds). A positive side to the use of alternatives that restrict herbicides is the favorable results obtained: no spray "drift" onto private land; no degradation of scenic values from "brown out"; no adverse effects from herbicides on wildlife and fish; and no adverse effects on public health from herbicides.

Methods of vegetation management that utilize off-road mechanical equipment could cause soil compaction and surface erosion. This, in turn, could have an impact on lands adjacent to and below the affected areas (see Chapter IV, Soil Resources).

Manual and biological methods are estimated to have low impacts on other lands.

Use of herbicides on National Forest lands and resulting effects can be reasonably predicted and mitigation measures put into effect. Large-scale use of herbicides by those landowners within National

Forest boundaries and by those adjacent to Forests is more difficult to predict. However, established, regular coordination meetings between large landowners and governmental agencies help greatly in predicting potential problems and planning for any necessary mitigation measures.

Recreation

The control of vegetation to improve recreation areas varies little in outputs and costs from alternative to alternative. Vegetation management techniques historically used for recreation sites consist almost exclusively of manual and mechanical methods. Herbicide sprays have been a preferred treatment for poison oak and other toxic plants. In the past, herbicides were applied in "spot" applications rather than broadcast spraying.

For those alternatives that allow use of herbicides (Alternatives B, D, E, F, G, and H), vegetation management may affect the availability of recreational opportunities through site closures, wildlife habitat changes, and the loss of edible fruits. Control of noxious weeds and toxic plants with herbicides may require temporary closure of areas, or warnings of possible contamination.

Since broadleaf plants which produce edible berries are included in the target species, there will be a temporary loss of berry picking opportunities in areas treated with herbicide. This could occur under all alternatives that allow herbicide use for such activities as noxious



Though herbicides have been a preferred treatment for poison oak and other toxic plants, vegetation management techniques historically used for recreation sites consist almost exclusively of manual and mechanical methods.

weed control, conifer release, and rights-of-way maintenance. There could be a loss of easily accessible berries along treated roadsides.

For those alternatives that allow prescribed burning, (Alternatives A, B, D, E, G, and H), air quality could be a problem both for developed recreation sites and dispersed recreation. Depending on timing and location, prescribed burning for programs such as range improvement, wildlife habitat improvement, plantation site preparation, and fire hazard reduction could have an effect on air quality for recreation users (see Chapter IV, Air Quality, for further discussion).

Facilities

The control of vegetation around Forest Service facilities (offices, dwellings, ranger station compounds, etc.) varies little from alternative to alternative. Almost all vegetation management is by manual or mechanical methods, with spot applications of herbicides for poison oak and other toxic plant control.

For those alternatives that do not allow herbicides (Alternatives A and C), other methods of dealing with toxic plants will be needed. Both cutting and burning have been used to control them, but this exposes employees to toxic effects and generally affords only temporary results.

Rights-of-Way

The effects on rights-of-way (for roads and highways, utility corridors, trails, and railroads) attributable to vegetation management is based on the degree to which the vegetation is manipulated.

Insufficient (or no) vegetation management activities could compromise safety along roads by not providing adequate sight distances; allow power outages from encroaching vegetation along utility corridors; contribute to wildfires along railroad rights-of-way; and lead to some environmental damage and loss of investment.

Roads and highways are particularly vulnerable to lack of treatment of unwanted vegetation along their rights-of-way.

For roads included under the Highway Safety Act of 1966, maintenance that assures public safety is required. To provide safe and efficient traffic movement, roadways and roadsides are to be maintained in a way consistent with the design standards used in construction. Management of vegetation is particularly important for providing safe sight distances for stopping; preventing restriction of roadway width; and providing adequate drainage to prevent safety problems.



Roads and highways are particularly vulnerable to lack of treatment of unwanted vegetation along their rights-of-way. Management of vegetation is especially important for providing save sight distances for driving; preventing restriction of roadway width; and providing adequate drainage to prevent safety problems.

Alternative C could eventually lead to some Forest road closures because of lack of vegetation control. Alternative A, at the costs shown in Table IV–15, would provide the vegetation control necessary to provide safety.

If Alternative A were implemented without the necessary funds, the total miles of roads which are brushed would be reduced, resulting in reduced standards (for example, some roads open to ordinary vehicles would become accessible to high-clearance vehicles only), or leading to possible future road closures.

Road closures become necessary when vegetation obscures safe sight distances or hinders drainage. This condition could result if funds available are not sufficient to accomplish the required work.

For the 88,000 mile Pacific Northwest Region road system, if Alternative A were implemented, it would cost approximately $1,750,000 more for vegetation control than for Alternative B, which is a likely Regional level. Alternatives E and F have costs similar to Alternative B (see Figure IV-8).

Fig. IV-8

Road Maintenance Cost by Alternative

Alternative	A	B	C	D	E	F	G	H
Source								
Costs (in million $)	4.02	2.28	2.44	2.42	2.25	2.26	2.69	2.36
Miles (of work accomplished)	12,660	12,660	8,842	12,660	12,636	12,660	14,884	12,660

Regionally, the annual average cost of treating Forest roads between 1980 and 1983 was estimated at approximately $2 million. About 12,000 miles per year were treated.

Alternative D treats the same number of miles of road as does Alternative B, but with annual costs that are approximately $140,000 higher. This increase is due to the higher initial cost of implementing biological controls. The costs for Alternative D two decades and beyond are the lowest of all alternatives (by approximately 15 percent) as the higher initial costs begin to pay off in reduced maintenance costs.

In comparison to Alternative B, Alternative C's costs are over $160,000 higher and roadside treatment is down by almost 4,000 miles. Alternative G has increased costs in proportion to increased miles treated, which, based on average costs, is equal to Alternatives B, E, and F.

Alternative H has higher costs for the same miles as Alternative B. This is due to higher initial costs in the way of doing business.

Although other Federal, state, and county agencies have sole responsibility for performing maintenance on their roads and facilities, the 1984 injunction against using herbicides applies to all lands under Forest Service jurisdiction. In other words, those agencies that operate roads and facilities under permit from the Federal government across National Forests in the Pacific Northwest Region are also currently prohibited from using chemical methods of vegetation management on those easements.

The Oregon Department of Transportation reports costs for those alternatives that do not allow herbicides (Alternatives A and C) to be about $124,000 more annually. This increased cost is for the short-term (that is, five to eight years). Costs over the long-term will be even higher as the rights-of-way become reinfested with unwanted vegetation. Increased amounts of unwanted vegetation require additional

manpower and equipment for control, thus increasing costs and inconvenience to the motoring public from more equipment operating in the roadway.

The Washington State Department of Transportation reports similarly high costs for Alternatives A and C. Long-term effects of not being able to use herbicide treatments include reduced surface drainage from pavements; deterioration of pavement surface contributing to unsafe driving conditions; loss of integrity of roadside hardware (signs, guard rails, and guideposts) due to accelerated deterioration or obscured visibility; and inadequate sight distance at intersections, on curves, and at game trail crossings.

It is anticipated that alternatives which do not allow herbicide use will result in non-treatment of additional miles of roads. The possibility of tort claims because of unsafe sight distance and drainage conditions will require development of a long-term management strategy, possibly resulting in the closure of some of the roads currently kept open.

Paved roads may be vulnerable to lack of vegetation management. Vegetation growing next to some paved surfaces may prevent the drainage of water beneath the pavement. This leads to a saturated subgrade, which generally results in structural failure to the pavement and increased reconstruction and maintenance costs. In addition, vegetation can restrict surface drainage from paved roads. This may result in excess water on the driving surface, which can result in hydroplaning. Herbicides have proven to be an effective tool in controlling this type of vegetation.

Conversely, vegetation on the slope between the ditch and the road acts as a filter to remove impurities and soil that could wash off the road and into the ditches.

From a visual standpoint, vegetation along roadsides that has been treated with herbicides is subject to foliage discoloration (brown out). This condition is usually temporary, lasting less than six months. The duration can be reduced by mechanically treating the dead vegetation.

Mechanical treatments of vegetation along roadsides can sometimes leave a ragged, ungroomed appearance. Depending on the timing of the treatment, this condition may no longer be apparent in as few as four to six weeks on West-side Forests, and within two to four months on East-side Forests.

Scenery

The National Forests of the Pacific Northwest Region have a variety of landscapes visible from many travel routes, including wilderness trails, developed recreation sites, lakes and rivers, and mountain tops and ridges.

Areas with a high degree of landscape variety that are viewed by many visitors are considered the most sensitive to changes. Areas with very little or no landscape variety which are not viewed by many visitors are considered less important for their scenic qualities.

The degree of contrast between human activity and the natural landscape determines its visual dominance. The degree of visual dominance created by vegetation management is a result of several factors:

1) the extent of the affected area (dominance increases as the visible portion of the project increases);

2) the shape of the project area (unnatural geometric lines and angles would contrast more than lines that follow the natural landscape character);

3) vegetation composition (variety, distribution of total vegetation cover, and target species);

4) natural openings (size and distribution);

5) soil color contrast (lighter soil colors have greater contrast potential); and

6) slope (as slopes increase, greater portions of the management activity will be visible).

Every vegetation management method will affect visual resources to some degree. The extent of the effect is ultimately determined by how well the treatment blends with the character of a given landscape.

Cultural Resources

The major purpose of the Region's cultural resource management program is to identify and enhance cultural resources, as specified by the various federal laws, regulations, and policies. (See Chapter III, Cultural Resources.)

From the perspective of cultural resources, vegetation management is only one phase of any given program. Timber sale and road building activities will have already altered the landscape to the greatest extent. The corresponding impact to cultural resources from follow-up vegetation management is expected to be low to moderately low.

Of the eight alternatives, those that allow the use of off-road mechanical equipment as a method to control vegetation will probably have the greatest effect on cultural resources. Alternative C, with the least amount of vegetation manipulation, should have little or no effect on cultural resources. Prescribed burning, use of herbicides, and manual methods are estimated to have low effects on cultural resources.

Federal law requires the National Forests to identify and negate or mitigate adverse impacts on eligible cultural resources that would result from any proposed undertaking. Specific mitigation measures for eligible resources will be determined on a case-by-case basis.

Energy Consumption and Production

Petroleum fuels (for vehicles, large and small machines, and other uses) are consumed during the treatment of unwanted vegetation under all of the alternatives. Petroleum used for managing vegetation is a small fraction of the total amount used for general management of the National Forests. In that context, there is no significant variation between the alternatives, except for Alternative C.

Those vegetation management alternatives that emphasize increased utilization of logging residues are likely to provide additional sources of energy—for example, firewood for homes, and "hog fuel" for industrial use.



Debris from logging activities provides potential fuel for domestic and industrial applications. Alternatives that emphasize increased utilization of logging residues (Alternatives D, F, and H) are likely to provide additional sources of energy—for example, firewood for homes and "hog fuel" for industrial uses. Some counterbalancing of this effect would occur with the expected reductions in harvest in these alternatives. The advantages of using this material are not always clear. Other fuels may be less expensive, and there are instances in which the use of wood-burning appliances must be restricted.

Chapter 4
Environmental Consequences

■ Human Health Effects

Human Health Effects

Risk Assessment

For each vegetation management tool, this section quantifies to the extent possible the health risks based on available data, discusses the quality of the data used to quantify risks and suggest human health concerns, and describes the potential human health effects that result from implementation of the vegetation management program. The discussion of herbicides, in particular, indicates deficiencies and/or lack of toxicity information and the uncertainties that pertain to characterization of hazards and risks as a result of incomplete toxicity information.

Manual Methods

Use of Manual Methods

Manual methods use hand labor to remove competing vegetation or noxious weeds or to create conditions favorable to a desired plant's growth. Techniques include removing brush with chainsaws, pulling weeds by hand, girdling stems, and scalping soil. Attachment 1 of the special appendix, Characterization and Management of Risk, is a profile of manual vegetation management tools.

Adverse Health Effects of Manual Methods

Working with such handtools as axes, brush hooks, machetes, and chainsaws can be hazardous under any circumstance. In forestry work, where site conditions can be extreme, handtools can be an even greater hazard. The risk of injuries increases if the size of the work crew increases or if the crew's work is required to be done in a relatively confined area. Worker fatigue can also increase the risk of injury. Workers could be cut by their tools, hit by falling brush, or fall onto the sharp ends of cut stumps or brush. Injuries can range from minor cuts, sprains, bruises, or abrasions to severe injuries such as major arterial bleeding or compound bone fractures. Unusually severe injuries may cause fatalities.

When temperatures are high, workers may experience increased fatigue, heat exhaustion, or heatstroke. Falls or other accidents may adversely affect pregnant female workers. Continued work in rugged terrain may initiate or exacerbate chronic health effects, such as ligament damage or arthritis. In extreme cases, exertion from manual methods in rugged terrain may bring on a heart attack or stroke in workers who are prone to such health effects. In addition, workers could be exposed to poison oak, ticks, and poisonous snakes.

Exposures to Handtools and Equipment

The likelihood of incurring injury appears to directly depend on the amount of worktime as described in the next section on the risk of manual method. Labor requirements vary with the type of work being done. Stavins et al. (1981) reported that labor requirements for Federal agencies in the Pacific Coast States were 2.5 to 5.0 person-days per acre for clearing and 0.75 to 3.125 person-days per acre for spot release treatment ranging from 25 to 100 percent of the brush being cut. The average was 3.75 days per acre for 100 percent clearing and 2.65 days per acre for all release treatments.

Quality of Information on Health Effects

The association between the health effects of manual methods and the use of the tools is fairly straightforward. For long-term health effects from the use of these tools, the associations may not be as evident, nor are records kept that would support these associations. Nevertheless, the relationship between hours worked and injury frequency appears to be a reliable one, so the quality of data is considered fair to good. The impact of the confounding variable, job experience, is not factored into the analysis.

Risks of Manual Methods

Up to the present, worker risk of minor and major injuries from manual methods in terms of the likelihood of injury per person-day worked has not been formally calculated. Several studies provide data for making estimates. Bernstein (1979) reported a frequency of one minor injury per 13 person-days with no major injuries, based on 265 person-days of brush removal. The same crew sustained a rate of one injury per 25 person-days during precommercial thinning. Roberts (1980) reported only minor accidents in 30 person-days of brush control with one near-miss of a serious eye injury. The Northwest Forest Workers Association experienced 29 hours of lost-time injuries per 100,000 hours worked and 47 reported injuries per 100,000 hours worked.

Brush-cutting injuries reported by the Bonneville Power Administration (1976-80) ranged from 2.5 to 10.3 injuries per 200,000 person-hours worked. During the same period, no chemical toxicity injuries or helicopter-related injuries were reported (U. S. Department of Energy,1983). Dost surveyed the Oregon State Accident Fund records for 1978-1979 to assess injury rates associated with forestry practices. Among the major items reported were strains and bruises (46.6 percent of reported accidents) eye injuries (8.6 percent), chainsaw cuts (7.0 percent), poison oak reactions (5.7 percent), fractures (4.8 percent), and

vehicle and equipment accidents (4.8 percent) (Dost,1981).

Newton and Dost (1984), using data from the Oregon State Accident Insurance Fund (SAIF) and estimates of the number of acres of Oregon forests cleared annually by manual methods for 1978-1983, calculated that one accident occurs for every 130 acres cleared manually (per 438 person-days of work). The estimate from this study is used for the calculation of worker injuries for manual methods under each alternative.

Members of the public are not at risk from manual methods. The tools are used by the workers, and no member of the public is likely to come near enough to be injured when such tools are in use.

Conclusions

Minor injuries are almost certain to occur with the use of handtools. Severe injuries may occur but at a much lower frequency. One human health effect of concern is the serious injury that can potentially result from the use of chainsaws. These injuries can be mitigated with such precautions as appropriate training, scheduled rest breaks, and equipment maintenance and repair.

Mechanical Methods

Use of Mechanical Equipment

Mechanical methods involve the use of tractors, graders, or cable systems to remove unwanted vegetation. Equipment attachments may include blades, mowers, brush cutters, or plows for site preparation, roadside brush control, or removal of unmerchantable material. Attachment 2 of the summary is a profile of mechanical vegetation management equipment and methods.

Adverse Health Effects of Mechanical Methods

The operator and other workers in the vicinity of the mechanical equipment are at risk of injury. Serious injuries could result if the operator loses control of the machine on steep terrain. Such accidents are uncommon among experienced operators, but they are difficult to avoid entirely. Accidents may occur when pushing brush under conditions of poor visibility, when encountering a short headwall or road cut, or when misjudging the slope. If the machine overturns, it could seriously injure the operator, as well as create flying debris that could pose a hazard.

Workers could be struck by falling trees or by debris thrown by the equipment while it is operating. In such cases, the operator's assistant on the ground is at greater risk than the operator, especially when

brush cutters or mowers are being used. A member of the public who enters an area where mechanical equipment is being used could also be injured by flying debris. Injuries also can result from working around large machines that tend to be slippery, oily, or otherwise capable of contributing to operator risk during service or repair. In addition, the high noise levels associated with the operation of heavy equipment may cause hearing impairment, such as a temporary hearing threshold shift for the public or permanent hearing loss for a worker.

Exposures to Mechanical Equipment

The equipment operator and ground crews are the only individuals liable to be exposed to injury from mechanical equipment. Members of the public are not likely to be in close enough proximity to the machine to be injured. The worker exposures would vary depending on the program acreage to be managed mechanically.

Quality of Information about Mechanical Method Health Effects

The quality of data on the health effects of mechanical methods is lower than that existing for manual effects. There is an intuitive relationship between equipment use and injury rate but no real evidence from forestry use on which to base that conclusion.

Risks of Mechanical Methods

Little data exist to assess risks from mechanical methods of vegetation management. However, an assessment of their impact was made by Newton and Dost (1984). The most serious accidents associated with mechanical methods involve the overturning of machinery. Other risks are associated with rolling or snapping vegetation. According to the authors, only four accidents associated with mechanical clearing were reported to the original SAIF in 1979. The accidentswere apparently not too severe, as they averaged less than $300 per claim. There was no acreage base available for these accidents. From these data it can be assumed that, while accidents are certainly a possibility with mechanical methods, both major and minor accidents are rare.

The risks to the general public from mechanical methods are very low. The only injuries to the public that are remotely possible from these methods are accidents resulting while the equipment is in transit from storage to the treatment site or in the extremely rare instance a member of the public ignores safety precautions and enters a treatment site while the equipment was in use.

Conclusions

Minor injuries are almost certain to result from the use of mechani-

cal equipment. Severe injuries are likely to be rare. A health effect of concern is the severe injury or fatality that might result from the overturning of heavy equipment. Special precautions instituted to minimize the likelihood of this occurring include appropriate training, scheduled rest breaks, regular equipment maintenance and repair, and warning signs for the public.

Prescribed Burning

Use of Prescribed Burning in Vegetation Management

Prescribed burning methods include broadcast burning of forest residues using drip torch or helitorch on a clearcut to prepare a site for planting, pile burning of unmerchantable material from cuttings using drip torches or remotely ignited gelled gasoline packets, and underburning beneath tree stands to set back unwanted vegetation or promote desired forage or browse species. Attachment 3 to the risk summary profiles prescribed burning methods.

Adverse Health Effects of Prescribed Burning

Short-Term Effects

Prescribed burning presents the combined hazards of fire and smoke to ground crews at the site. Effects on workers may range from eye irritation, coughing, and shortness of breath in moderate-to-heavy smoke, to severe burns that may result in permanent tissue damage. Workers trapped in an area of heavy smoke may be asphyxiated. Where a burn escapes and causes a wildfire, severe worker injuries and fatalities may result. Wildfire and heavy smoke also may endanger members of the public in adjacent areas. In the extreme case, wildfire may trap and kill members of the public.

Long-Term Effects

Lower levels of smoke from prescribed burns may have a local, transitory effect on air quality. Sensitive members of the public may experience eye, throat, or lung irritation from these exposures. There is some risk that chronic, low-level exposure of workers or the public to smoke may lead to such health effects as emphysema or lung cancer.

Toxicity of Smoke Constituents

The various components of forest fire smoke are fairly well known, but the quantities produced vary considerably, depending on fuel moisture and fire temperature (Oregon Department of Environmental Quality,1987). The hazards include particulate matter, gases (carbon monoxide, carbon dioxide, and oxides of nitrogen), and chemicals that may enter the lungs on the surface of particulate matter.

There are few studies which evaluate the toxicity of forest fire smoke. Almost all investigations of the toxicity of smoke particulate matter in human populations have been conducted with particulates associated with burning coal or fossil fuels (for example, automobile exhaust) where sulfur oxides and sulfates are the important constituents. However, these chemicals are not generated in a significant quantity by vegetation fires.

The vast majority of particulate matter generated by forest fires is thought to be in the fine particulate (FP) range in which 90 percent is less than 2.5 microns in diameter (Oregon DEQ,1987b). These small particulates can be inhaled deeply into the lungs and deposited there.

Some components, such as many polycyclic aromatic hydrocarbons (PAH), are carcinogenic. Probably the most toxic is benzo-a-pyrene (BaP), which has been demonstrated to increase in potency when mixed with carbon particulates (Dost,1986). Other components, such as the aldehydes, are acute irritants. These are most likely to affect forest workers who receive high exposures at the burn site.

In some cases, irritants unique to a certain plant may be released upon burning. For example, the specific toxic agent in poison oak has been responsible for a large number of workers being out of work for long periods because of slow recovery from allergic reactions.

Fire and Smoke Exposures

Fire Exposures

Worker and public exposures to fire depend on the number of escaped wildfires. Public exposures should be rare given the normal precautions used in prescribed burning.

Smoke Exposures

The gaseous components of smoke generally decompose or are diluted relatively quickly; other components, such as the aldehydes, may attach themselves to the particulates formed, and thus remain more concentrated and possibly protected from decomposition (Dost,1986). For these reasons, exposures to smoke have generally been estimated by measuring particulate concentrations in the air. This would not necessarily be a good estimate for people in close contact with fire smoke, such as the workers.

Estimating the concentration of toxic substances in fire smoke involves determining drift, dilution, and breakdown of the various components. Knowledge of these factors and the ability to predict smoke exposures based on them are not well developed. Estimates of

risk are based on the few data available on measured particulate concentrations.

While some smoke dispersion models do exist, there has been no generally accepted application of these models to smoke dispersion of forest fires. However, direct measurements of air concentrations of particulate matter have been made in communities located near areas of forest slash burns (Oregon Department of Environmental Quality,1986). Five locations were sampled in 1985, based upon proximity and wind direction (downwind) from areas with field and slash burning. Total suspended particulates (TSP) and particulate matter under 10 microns (PM-10) were measured (Oregon Department of Environmental Quality,1986). The highest 24-hour average TSP measurement was 83 micrograms per cubic meter (ug/m^3). The highest 24-hour average PM-10 measurement was 60 ug/m^3. These studies represent estimates of the maximum impact of slash burning on air quality over population centers.

Exposures for Forest Service workers managing prescribed fires or fighting wildfires would be much greater than these exposures. No direct measurements of worker exposures have been made, and it is not possible in this analysis to estimate with any degree of accuracy what smoke exposures would occur.

Quality of Information on Prescribed Burning Effects

Information on the likely effects of prescribed burning is poor. Most conclusions must be extrapolated from studies of air pollution from automobile emissions and other types of burning activities.

Risks from Prescribed Burning

Prescribed burning risks include the risk of wildfire, risk of physical injury to workers, and risk of chemical or particulate effects from smoke.

Risk of Wildfire

There may be numerous wildfires resulting from escaped prescribed burns, but they should be limited in size and should not present a serious risk to the public. All controlled burns require a burning prescription, which includes a description and discussion of fuels, weather, and timing; how to burn; and safeguards. Personnel qualification standards and training requirements have been established for workers involved in control burning. These requirements are directed toward reducing the risk of wildfire.

In the Pacific Northwest, fuel hazard abatement, coupled with

increased efficiency in fire suppression, has reduced wildfire acreage (Tiedemann,1981). A significant proportion of the wildfires and acreage burned by wildfire on National Forests are attributable to escaped prescribed fires. From 1974 through 1984, escaped slash fires accounted for 7.5 percent of the wildfires and 27 percent of the burned acreage. Escaped slash fires averaged 34 acres in size.

Risk of Physical Injury to Workers

The risk of physical injury to workers is similar to that of manual methods. Workers on burn areas would be exposed to potential injury resulting from the manual treatments (brush piling, cutting) performed and the site conditions. Workers who manually light burn areas would be exposed to burning materials. There also could be a significant hazard associated with the mixing of gelled gasoline.

Data on typical casualty costs of controlled burning in Pacific Northwest forests (including 1 to 3 years of data from the Wenatchee National Forest and from two forest industries operating in northwest Oregon) suggest that one minor injury will occur for every 500 acres burned, and one disabling injury will occur for every 7,500 acres burned. On three National Forests surveyed in the Pacific Southwest Region, there were 1,348 areas burned and only 15 personnel injuries, which is one for every 90 controlled burns.

Public safety would not be affected by any method of igniting burn areas. Most burning would occur in locations where the public either would not be present or would be highly visible to those doing the burning. Furthermore, those on or near a burning area would be well aware of impending activities because several hours of active preparation are required before ignition begins. Safety measures normally taken to protect firefighters participating in the prescribed burning also would protect the public.

Risk of Chemical or Particulate Effects from Smoke

It is not possible to accurately quantify human health risk from fire smoke. One of the major problems associated with the use of human epidemiology studies to evaluate the effects of fire smoke is the variation in the composition of the air pollutants studied. Most of these studies have been carried out in urban areas with considerable particulate concentrations from automobile and industrial combustion of gasoline, diesel fuel, oil, and coal. All these sources include various components not found in fire smoke.

Air pollution has been clearly associated with mortality and morbidity. However, the health effects of air pollution caused by slash

burning and wildfires have not been directly studied.

The highest level of TSP associated with slash burning observed in Oregon was 83 ug/m^3. This level slightly exceeds the lowest estimated concentrations for intermediate particulates (IP) associated with chronic effects. The IP measurement is more restrictive than TSP, and therefore, the TSP overestimates the particulate concentration when compared to IP.

Thus, the highest level of particulate air pollutionmeasured in Oregon approximately equals the lowest level of particulate air pollution at which observed chronic effects have been reported. This level does not necessarily reflect a no-effect level. There is no evidence available to establish a no- effect threshold for fire smoke.

The confidence that no adverse human health effects will occur because of exposure to fire smoke at levels reaching population centers is uncertain. It is not possible at this time to quantify expected impacts. Observed particulate levels suggest that prescribed fire will not cause particulate levels to exceed the PM-10 standard (150 ug/m^3) proposed by the Environmental Protection Agency (EPA) (Oregon Department of Environmental Quality,1986).

Exposure of forest workers managing or fighting fires is likely to exceed levels with demonstrated health effects. Thus, the degree of confidence that no health effect would occur among these workers is very low.

An estimate of cancer risks due to PAH from smoke inhalation was made by Dost (1986) using EPA's estimate of carcinogenic potency for BaP (a 0.0033 excess lifetime risk for cancer from continuous exposure to 1 ug/m^3) and assumed exposure levels for the public. His upper estimate of risk was in the range of one additional cancer per million people exposed (a one in 1 million individual cancer risk).

Conclusions

Workers are liable to experience injury and short-term effects from fire and smoke. They are at particular risk from wildfires resulting when a prescribed burn escapes. The public is not liable to incur serious injury, although there is some indication that members of the public may experience long-term health effects from toxic constituents in fire smoke should they be exposed at relatively high levels that exceed state air quality standards. Workers are far more likely to experience cancer or emphysema from their exposures.

Biological Methods

Use of Biological Methods in Vegetation Management

Biological methods of vegetation management have included prolonged or forced grazing of cattle, goats, and sheep for conifer release and the selective introduction of parasitic insects for control of noxious weeds. In grazing for vegetation control, the water normally is provided, and livestock dispersal and movement is maintained through salting patterns and use of riders or herders. Attachment 4 to the risk summary profiles biological methods of vegetation management.

Adverse Health Effects of Biological Methods

Cattle or sheep are normally held in a plantation or confined area long enough to afford heavy utilization of feed and to generate a "release" effect in the crop trees. This combination of livestock numbers and duration of grazing may result in relatively high volumes of fecal matter deposited on the site. This factor, as well as the tendency for animals to concentrate in draw bottoms and adjacent to live water, creates a potential for fecal contamination of surface waters.

Exposures from Biological Methods

Members of the public who consume surface water downstream of biologically controlled sites may be exposed. Pathogens are not likely to contribute significantly to major municipal drinking water supplies and therefore, larger populations are not likely to be at risk.

Quality of Information on Biological Method Health Effects

Little or no information exists on the spread of water-borne pathogens or the incidence of human illness that could be attributed to them from biological vegetation management.

Risks of Biological Methods

There is a remote possibility that fecal contamination of surface waters could result in the spread of waterborne diseases if animals were used to manage competing vegetation. It is not anticipated that such contamination would impact health to any greater degree than normally occurs from wildlife in the forest. Stock tanks and methods to ensure animal movement and dispersal within the treatment area could be used as mitigation measures if necessary.

Conclusions

Human health effects are not likely to be caused by the use of biological methods. At present, there is insufficient evidence to conclude that waterborne disease is a human health effect of concern from the use of biological controls in this program. Downstream monitoring will be maintained in any projects where there is a question of potential human impacts.

Human Health Effects of Herbicides

Characterization of Risk For 16 Herbicides

The toxicity of the 16 herbicides used in vegetation management has been evaluated in particular detail for this EIS.

A quantitative worst case analysis was developed under contract with Labat-Anderson, Inc. (LAI), and is included in Appendix D. LAI worked closely with the Environmental Protection Agency (EPA) to obtain the latest information being evaluated for the reregistration of these herbicides. They also did a review of the scientific literature. A major portion of the LAI analysis was devoted to developing an array of possible application scenarios to assess potential exposures to the public and to contractors applying the herbicides. Another major portion was providing expertise in toxicology and making quantitative assessment of risk associated with each of the scenarios.

In addition, the Forest Service contracted with the University of Washington (UW) to provide additional expertise in the fields of toxicology and public health. Through this arrangement, a qualitative evaluation of available information on herbicide toxicity was developed.

Several other sources of information.were also reviewed for this EIS. These include the "Worst Case Analysis Study on Forest Plantation Herbicide Use" prepared for the Department of Natural Resources, State of Washington, by K.S. Crump and Company, Inc. (Crump,1986); the "Medical Toxicology Reviews" produced by the California Department of Food and Agriculture, Division of Pesticide Management; and "Registration Guidelines" and "Registration Standards" produced by the U.S. Environmental Protection Agency, Office of Pesticide Programs.

The University of Washington team did an independent review of the literature, drawing upon the studies identified by LAI, as well as those used by Crump. This review drew on literature published after LAI's review, and also included a survey of scientific literature germaine to a qualitative analysis.

When possible, original studies were reviewed. However, it was necessary to rely upon published reviews of studies in most cases. In all cases, an effort was made to document clearly where information was obtained so that it could readily be reviewed by the public. University of Washington and LAI conferred and jointly resolved differences when differences of interpretation existed or discrepancies in the data were found.

A major goal of the University of Washington effort was to determine the confidence that could be placed on the characterization of herbicide toxicity, which is based on the adequacy of the studies and data. The adequacy of each study used is rated in the toxicology summaries in Appendix H. Ratings of the adequacy of total information for each of seven types of toxicity were based upon the number of studies for the particular effect; the adequacy of the studies in terms of data, methodology, and conclusions; and the agreement between these studies.

These ratings of adequacy are not hard scientific facts,. Differences of interpretation existed within the University of Washington team, as they do in the general public. These differences are expressed in the degree of certainty or uncertainty assigned in these evaluations, and are the consensus of the University of Washington team.

The two risk assessments conducted by LAI and the University of Washington are each in their own right useful in characterizing risks posed by exposures to herbicides. While neither assessment is dependent on the other, both have proved complementary. Each can stand on its own, and each provides useful information.

Overview of Risk Characterization

The process of risk assessment by government agencies was studied by the National Research Council Committee on the Institutional Means for Assessment of Risks to Public Health (the NRC Committee). The NRC Committee found that risk assessment was a distinct and separate function from risk management, although it is clearly related to risk management:

> "Risk management is the process of weighing policy alternatives and selecting the most appropriate regulatory action, integrating the results of risk assessment with engineering data and with social, economic, and political concerns to reach a decision." (NRC Committee, 1983, p. 3)

As the NRC Committee noted:

> "Risk assessment is an analytic process that is firmly based on scientific considerations, but it also requires judgments to be made when the available information is incomplete. These judgments inevitably draw on both scientific and policy considerations." (p. 48)

> "Two kinds of policy can potentially affect risk assessment: that which is inherent in the assessent process itself and that which

governs the selection of regulatory options. The latter, risk management policy, should not be allowed to control the former, risk assessment policy." (p. 49)

There is general, though not complete, agreement in the scientific community on how to make quantitative assessments of risk. There is no agreement in the scientific community, nor are there standard methodologies or guidelines, on how to evaluate uncertainty and quality of information. The LAI effort follows practices generally accepted in the scientific community to make quantitative assessment of risk. The approach used by the Forest Service with the assistance of the University of Washington, represents a first attempt to explicitly deal with issues of uncertainty and quality of information. As such, the approach is subject to improvement as others gain experience in dealing with the issue.

Use of Herbicides in Vegetation Management

Herbicides are used in a variety of areas to control competing and unwanted vegetation. They most often are applied in mixtures with water or oil carriers, various adjuvants (wetting agents, sticking agents, stabilizers, enhancers, or thickeners), and dyes. The most frequently used methods for applying herbicides are helicopter and backpack applications for site preparation and release, and trucks for right-of-way maintenance. Table IV-14 lists the 16 herbicides considered for use in Region 6, showing the specific vegetation management needs for which they are targeted. Attachment 5 to the risk summary describes the toxicology and quality of toxicity data for the 16 herbicides.

Adverse Health Effects of Herbicides

Conclusions about the toxic properties of herbicides are drawn from poisoning incidents, from laboratory studies of effects seen in human volunteers, from epidemiology studies, and from laboratory studies of effects seen in animals. Each of these types of information is associated with certain advantages and disadvantages, including uncertainties in predicting the effects of a chemical on an exposed individual.

Reports of poisoning most often indicate only the effects of very large doses, and the exact dose is seldom known. Laboratory studies on human volunteers, however, are confined to relatively small doses and are limited in duration. Epidemiology studies correlate disease observed in segments of the public with exposure to chemicals in the workplace or other areas. Results of epidemiology studies depend on data that is sometimes only secondhand or questionable, and in many cases confounding factors, such as exposures to other chemicals or

smoking, exist. Laboratory animal studies are the most controlled of the methods and examine effects under a wide range of doses and study durations, but uncertainty is involved in extrapolating the results of these studies to humans. This uncertainty is particularly relevant where the effects are seen as equivocal or seen only at very high doses that humans are not likely to receive.

Toxic effects may be caused by the active ingredient in the herbicide formulation in a single dose, by a series of doses received over time (a cumulative dose), or by a combination of the herbicide active ingredient and another chemical (such as another herbicide, a carrier, or an inert used in the herbicide formulation).

Toxic Properties of the Individual Herbicides

Incidents of poisoning have shown that the 16 herbicides may cause severe, immediate reactions when received in high enough doses. However, such doses are rarely seen with these herbicides except in the cases of accidental or suicidal ingestion of concentrate. Even in these instances, the herbicides rarely have proven fatal. The herbicides may cause lower level immediate effects, such as nausea, dizziness, or reversible neuropathy. Longer term effects might include permanent nervous system damage; effects on reproductive success; damage to developing offspring; production of heritable mutations; damage to liver, kidneys, or other organs; damage to the function of the immune system; and cancer. These effects have been shown for a number of the 16 herbicides in laboratory animal studies. Therefore, it is assumed here that there is a risk that they might occur at some dose levels in humans. There is also suggestive evidence from epidemiological studies that these effects could occur in humans.

Only a few of the 16 herbicides in the program have been examined in epidemiology or human volunteer studies, so judgments about toxic effects rely most heavily on the results of studies in laboratory animals. The toxic properties of the 16 herbicides are summarized in three tables.

Table IV-15 categorizes health hazards for acute effects, general health effects, cancer and mutagenicity, and reproductive and developmental effects according to the compound evaluation system employed by the USDA Food Safety Inspection Service. This table is intended to show the maximum inherent toxic effects of a given chemical and indicates only the effects of very large doses. This table *does not* show effects expected from herbicides used in the Region's vegetation management program. Actual and potential exposures from the program, even under worst case conditions, will result in

Table IV-14

Proposed Herbicide Program Use: Target Vegetation and Percent of Acreage Treated

Program Chemicals	Percent of Program Use	Treated Acreage
Herbicides		
2,4-D	Broadleaved weeds and herbaceous plants	38 %
Glyphosate	Broadleaved weeds and grasses	31
Picloram	Noxious weeds and shrubs	8
Triclopyr	Woody plants and broadleaved weeds	7
Dalapon	Annual and perennial grasses & sedges	Less than 5
Atrazine	Annual grasses	Less than 5
2,4-DP	Broadleaved weeds and herbaceous plants	Less than 5
Hexazinone	Most broadleaved weeds and grasses	Less than 5
Fosamine	Hardwood shrubs	Less than 5
Dicamba	Broadleaved weeds and brush	Less than 5
Asulam	Bracken fern, broadleaved weeds perennial grasses	Less than 5
Tebuthiuron	Woody range species	Less than 5
Diuron	Grasses and broadleaved weeds	Less than 5
Simazine	Annual grasses	Less than 5
Bromacil	Broadleaved weeds, grasses, shrubs	Less than 5
Amitrole	Annual & perennial grasses and herbaceous vegetation	Less than 5
Other Chemicals		
Diesel oil	Carrier for herbicides	—
Kerosene	Inert ingredient in formulations of 2,4-D and triclopyr	—

doses which are very much smaller than the doses necessary for the health effects displayed in this table. Data on the specific effects are based on studies detailed in the three appendices on human health.

Table IV-16 describes effects reported in studies on systemic toxicity, cancer, and reproductive and developmental toxicity, as well as testing for neurotoxicity or immunotoxicity. Summary statements indicate the principal effects reported with a dose sufficiently large to be toxic for each herbicide. This table is intended to show what the results could be if exposed to very large doses. This table does not show the effects expected from the Region's vegetation management program. Actual and potential exposures from herbicides used in the program, even under worst case conditions, will result in doses which are very much smaller than the doses necessary for the health effects displayed in this table. Data on the specific effects are based on studies detailed in the three appendices on human health.

The effects shown in Table IV-16 are summaries of effects reported at varying doses for tests conducted on laboratory animals and reported from human exposures. Not all effects were seen in all tests, nor with all listed species. Any major effect seen has been noted regardless of the quality of data, and whether the results were of laboratory tests on rats, dogs, rabbits, or observations of humans. Testing protocols for assessing neurologic and immunologic effects have not been established by either the scientific community or the Environmental Protection Agency. In all but a few cases, existing data is inadequate. Sometimes neurologic or immunologic effects are noted in testing and other toxilogical endpoints. The reported effects are shown in the table.

Table IV-17 outlines the quality of the data on which the summary profiles in Tables IV-15 and IV-16 were based, and on which the overall assessment of risk in this document is based. Profiles of the toxicity and data quality of each herbicide are given in Attachment 5 to the appendix on Characterization and Management of Risk, jointly prepared by the Forest Service, LAI, and the University of Washington (UW). Detailed discussions of toxicity are given in Appendix D, compiled by LAI. Data quality is addressed in Appendix H, compiled by the University of Washington. The quality of data for each of six human health effects was categorized into one of four categories:

I Inadequate information available for evaluating toxicity. There were too few studies of sufficient quality to yield useful or reliable information.

M-I Some useable information exists for evalating toxicity for the given health effect. There were some studies of marginal quality

that provided useful information, but studies were inconsistent, and some contained flaws. It is likely that new studies whould change estimates of health effects.

M Marginal but useable information available for evaluating toxicity. There were studies of adequate quality and results did not vary greatly, but more information would increase reliability. Although new studies may change estimates of health effects, the results are considered moderately reliable.

A Adequate information is available. Studies are of sufficient quality and quantity that estimates of human health are considered reliable. New studies are unlikely to change estimates of human health effects.

Other Hazards

Inert Ingredients and Carriers

Inert and carrier ingredients are chemicals added to the active ingredient to facilitate the effective application of the pesticide. However, inert ingredients and carriers in certain formulations and under certain conditions have the potential to be a hazard to human health.

Assessing human health risks of inert and carrier ingredients is difficult because there is an extremely limited data base on human health effects, and because inert ingredients are considered confidential business information. Inert ingredients are not stated on the label or made available to agencies or the public.

The Environmental Protection Agency (EPA) has identified about 1,200 inert ingredients that are used in registered pesticides. EPA reviewed the existing human health data on inert ingredients (which include common carriers). The existing data include laboratory studies, epidemiological studies, and activity/structure relationships. EPA catagorized inert ingredients into one of four categories:

List 1 Contains approximately 55 inert ingredients that have been shown to be carcinogens, developmental toxicants, neurotoxins, or potential ecological hazards. These ingredients are the highest priority for regulatory action.

List 2 Contains approximately 50 inert ingredients that have been given high priority for testing because the data is suggestive, but not conclusive, of possible adverse health effects or because they have structures similar to chemicals in List 1.

List 3 Contains approximately 800 inert ingredients that are of lower priority for testing because no evidence from data or similarity of structure to chemicals in List 1 support a concern for toxicity or risk.

List 4 Contains approximately 300 inert ingredients that are generally recognized as safe.

The Forest Service supplied EPA with a list of all formulations of the 16 herbicides being considered for use in the region. EPA reported to the Forest Service that formulations of 14 of the herbicides proposed for use contain no ingredients on List 1 or List 2.

The esther formulations of triclopyr and the esther formulations of 2,4-D were reported to contain kerosene, which is classified as very slightly toxic (about 70 times less poisonous than 2,4-D) to laboratory rats. However, kerosene is a skin irritant. Kerosene was negative in five short-term assays for DNA damage and chromosome damage. Although it has not been shown to cause cancer in laboratory animals, it has a calculated cancer potency because it contains small amounts of such chemicals as benzene and BaP that are known to cause cancer. The calculated cancer potency of kerosene is about 6,000 times lower than the 2,4-D cancer potency.

Diesel oil is used as an herbicide carrier in tank mixtures. It is similar to kerosene in composition and contains benzene and BaP. Its toxicity is assumed to be about the same as kerosene. As indicated in Table IV-15, little information exists for categorizing the health hazards of kerosene or diesel oil.

The formulations proposed for use by the Forest Service are less acutely toxic than their active ingredient. However, none of the herbicide formulations have undergone chronic toxicity testing, including cancer testing, or any reproductive, developmental, or mutagenicity testing. The inert ingredients in the proposed formulated products might cause cancer or other long-term health effects.

Given the little information that is available on each herbicide's formulation, the possibility that the formulated product is more toxic than the active ingredient cannot be discounted entirely. Neither can it be assumed to be true. For this reason, as well as others, very conservative assumptions that tend to overstate risk were made throughout the process of assessing risks contained in this EIS and associated appendices.

Table IV-15

Summary of Potential Toxic Effects (Health Hazards) for 16 Herbicides

Herbicide	Acute (Poisoning)	Systemic (General Health)	Cancer or Mutagenic	Reproductive/ Developmental
2,4-D	Low	High	Low/Moderate Insufficient Info.	High
Glyphosate	Negligible	Low	Mod./Insuf. Info.	Moderate
Picloram	Negligible	Low/Mod.	Mod./Insuf. Info.	Low/Moderate
Triclopyr	Low	Moderate	Moderate	High
Dalapon	Negligible	Low	Neg./Insuf. Info.	Insuf. Info.
Atrazine	Low	Low/Mod.	Moderate	High
2,4-DP	Low	Moderate	Moderate	High
Hexazinone	Negligible	Low/Mod.	Low/Insuf. Info.	Low/Moderate
Fosamine	Negligible	Insuf. Info.	Insuf. Info.	Insuf. Info.
Dicamba	Low	Low	Low/Insuf. Info.	High
Asulam	Negligible	Low	Moderate	Moderate
Tebuthiuron	Low	Low	Neg./Insuf. Info.	Low/Moderate
Diuron	Negligible	Insuf. Info.	Insuf. Info.	Insuf. Info.
Simazine	Negligible	Low	Insuf. Info.	Moderate
Bromacil	Negligible	Low/Mod.	Moderate	Low
Amitrole	Negligible	Moderate	High	Insuf. Info.
Diesel Oil	Negligible	Insuf. Info.	Insuf. Info.	Insuf. Info.
Kerosene	Negligible	Insuf. Info.	Insuf. Info.	Insuf. Info.

This table categorizes health effects according to the compound evaluation system developed by the Food Safety Inspection Service. This table is intended to show the maximum inherent toxic effects for a given chemical and indicates only the effects of very large doses. This table does not show the effects expected from the Region's vegetation management program. Actual and potential exposure from herbicides used in the program, even under worst case conditions, will result in doses which are very much smaller than the doses necessary for the health effects displayed in this table. Data on the specific effects are based on studies detailed in the three appendices on human health.

Legend	Acute Toxicity: Oral LD50 (Mg/Kg of Body Weight)	Systemic Observed Damage to Vital Functions	Mutagenicity Carcinogenicity	Reproductive/ Developmental
High	25 or less	Irreversible	Mutagenic, confirmed carcinogenic (EPA Class A & B)	Adverse effects in rodents & nonrodents or conclusive in one species
Moderate	25-250	Serious and reversible	Weakly mutagenic, some evidence of carcinogenicity (EPA Class C)	Suspected adverse effects in one species
Low	250-1000	Transient and not permanent	Weakly mutagenic, negative cancer test	No adverse effects
Negligible	Greater than1000	None	Negative mutagenic and cancer test results (EPA Class D)	
Insufficient Information				

Table IV-16

Overview of Toxicity Information Available on the 16 Herbicides

Toxicity	Amitrole	Asulam	Atrazine
Systemic	Eye irritation, enlarged thyroid glands, reduced iodine uptake, decreased thyroid function, decreased body weight.	Gastrointestinal disorders, inflammation. Increased thyroid, heart, kidney, and body weights. Adrenal and pituitary gland changes in organ/body weight ratio. Fatty liver.	Eye and skin irritation. Decreased growth, food consumption. Decreased relative and absolute kidney and liver weights.
Cancer	Thyroid and liver tumors.	Questionable incidence of skin and subcutaneous undifferentiated sarcomas. Follicular thyroid hyperplasia. Possible pheochromocytoma.	Increase in female mammary adenocarcinomas and fibroadenomas. Increase in testicular interstitial tumors.
Reproductive	Hyperplasia of thyroid and atropic thymuses and spleens indicative of runting.	Decrease in number of live births. Reduced maternal weight gain.	Increased reabsorption. Reduced maternal weight gain.
Developmental	Abortions, structural changes, and decreased weight gain have been seen in some animal studies.	Minor abnormalities.	Increased visceral & skeletal variability. Weight loss. Fetal mortality.
Neurologic*	Insufficient information, no reported effects.	Vomiting and anorexia. Tremors, ataxia, hypoactivity. Learning impairment, alteration in EEG activity.	Insufficient information, no reported effects.
Immunologic*	Insufficient information, no reported effects.	Insufficient information, no reported effects.	Lymphopenia in rats.
Summary (General Toxicity)	Thyroid cancer.	Liver changes.	Body weight.

Toxicity	Bromacil	2,4-D	2,4-DP
Systemic	Gastrointestinal disorders. Decreased weight gain and growth. Changes in thyroid activity. Liver effects. CNS effects, impaired coordination.	Liver/kidney alterations. Decreased lymphocyte counts. Bleeding gums.	Blood enzyme effects, liver/kidney effects, decreased body weight.
Cancer	Liver tumors.	Increase in total malignant tumors. Brain tumors. Reticulum cell sarcoma. Liver, lung tumor increases. Lymphosarcomas, mammary tumors.	Pituitary and thyroid medullary tumors. Increase in rare malignant brain tumors.
Reproductive	Testicular abnormalities.	Decreased maternal survival. Increased fetal loss.	Decreased bulk. Reduced litter size. Pup mortality.
Developmental	Inadequate data.	Delayed ossification. Fetotoxicity. Skeletal abnormalities. Hydrocephaly.	Growth retardation. Skeletal malformations. Omphalocele.
Neurologic*	Insufficient information, no reported effects.	Histopathological lesions in CNS. Neuropathies. Memory impairment, polyneuritis. Brain lesions. Decreased nerve conduction velocity. EEG alterations. Myotonia.	Insufficient information, no reported effects.
Immunologic*	Insufficient information, no reported effects.	Altered immune function. In utero effects on lymphocytes. Antibody production suppressed.	Insufficient information, no reported effects.
Summary	Thyroid/liver changes.	Kidney/neurological.	Liver/clinical chemistry.

Toxicity	Dalapon	Dicamba	Diuron
Systemic	Kidney/liver effects.	Eye irritant. Skin rashes. Decreased food consumption and body weight. Liver changes, muscle cramps, dizziness, nausea, vomiting, voice loss, swelling of cervical glands.	Slight anemia, enlarged spleens, increased erythrogenic activity in bone marrow. Liver effects. Abnormal blood pigments. Weight loss. Nervous depression. Decreased respiration and heart rate. Weakness. Lethargy.
Cancer	None reported.	Considered negative, but some evidence of lymphoma and angiosarcomas suspected in 1 study.	Inadequate testing.
Reproduction	Maternal toxicity.	Maternal mortality. Decreased food consumption and body weight. Maternal ataxia.	Decreased maternal body weight.
Developmental	Decrease in maternal weight gain. Fetal resorption. Decreased pup weights.	Skeletal changes. Increased fetal resorptions. Reduced fetal body weights.	Fetal weight decrease. Wavy ribs. Delayed ossification. Sternoschisis.
Neurologic*	Insufficient information, no reported effects.	Sciatic nerve damage.	Insufficient information, no reported effects.
Immunologic*	Insufficient information, no reported effects.	No reported effects.	Increased spleen weight.
Summary	Kidney changes.	Body weight.	Effects on blood and liver.

Toxicity	Fosamine	Glyphosate	Hexazinone
Systemic	Increased heart, stomach, brain, kidney weights. Mild skin irritation. Possible changes in blood enzymes.	Decreased food consumption and body weight gain. Liver/kidney effects. Increased mortality. Decreased pituitary weight.	Lethargy. Irregular respiration. Eye irritation. Vomiting. Reduced weight gain. Liver changes. Decreased albumin. Increased alkaline phosphatase. Tremors, convulsions.
Cancer	No specific studies.	Testicular tumors. Renal tubular adenomas.	No oncogenic effects observed.
Reproductive	Inadequate data.	Maternal toxicity included inactivity, death, stomach hemorrhages, decreased weight gain.	Maternal decreased food consumption and weight gain.
Developmental	Hydronephosis (urine in kidney). Resorptions.	Delayed ossification. Structural malformation.	Abnormal skeletal development. Delayed ossification in extremities and extra ribs.
Neurologic*	Tremors and convulsions.	Insufficient information, no reported effects.	Insufficient information, no reported effects.
Immunologic*	Insufficient information, no reported effects.	Insufficient information, no reported effects.	Insufficient information, no reported effects.
Summary	Stomach weight.	Kidney changes. Liver weight.	Liver weight. Body weight.

Toxicity	Picloram	Simazine	Tebuthiuron
Systemic	Sensitizing reactions in humans. Increased liver weights. Altered liver cells. Mortality. Kidney lesions. Alterations in blood chemistry, body and organ weights.	Eye and skin irritant. Reduced erythrocyte and leukocyte counts. Elevated cholesterol and inorganic phosphate. Decreased body weight gain and food consumption. Decreased albumin; increased globulin, ketone levels. Urinary specific gravity.	Decreased growth. Hepatotoxic effect. Weight suppression. Increased thyroid and spleen weights. Pancreatic lesions. Increased liver and kidney-to-body weight ratios. Enzyme values increased.
Cancer	Benign adrenal, pituitary, liver, mammary and thyroid tumors. Small intestine adenocarcinomas. Increased neoplasms of spleen.	Inadequate testing.	No evidence.
Reproductive	Maternal toxicity. Reduced fertility at highest dose.	Tremors, abortion, decreased body weight gain and decreased food consumption.	Decreased body weight of weanling pups.
Developmental	Delayed bone ossification.	Reduced mean fetal weight. Increased skeletal variations. Late resorptions.	Inadequate data.
Neurologic*	Insufficient information, no reported effects.	Tremors. Labored breathing. Incoordination. Paralysis. Decreased brain weight. Hypoactivity. Muscular weakness. Convulsions. Ataxia.	Hyper-irritability. Tremors. Convulsions. Loss of righting reflex. Ataxia. Emesis.
Immunologic*	Insufficient information, no reported effects.	Insufficient information, no reported effects.	Insufficient information, no reported effects.
Summary	Liver weight.	Blood cell count.	Thyroid weight. Reduced growth.

Toxicity	Triclopyr
Systemic	Eye and skin irritant. Decreased weight gains, food consumption, absolute liver weights, growth rate. Liver and kidney effects. Gastrointestinal irritation. Increased mortality.
Cancer	Lung tumors. Mammary tumors.
Reproductive	Maternal decrease in body weight gain and food consumption.
Developmental	Maternal toxicity. Retarded ossification of skull bones. Fetotoxic effects. Increased resorptions.
Neurologic*	Insufficient information, no reported effects.
Immunologic*	Insufficient information, no reported effects.
Summary	Liver changes.

* This table describes effects reported in studies on systemic toxicity, cancer and reproductive toxicity, as well as testing for neurotoxicity and immunotoxicity. Summary statements indicate the principal effects reported with a dose sufficiently large to be toxic for each herbicide. This table is intended to show what the results could be if exposed to very large doses. This table does not show the effects expected from the Region's vegetation management program. Actual and potential exposures from herbicides used in the program, even under worst case conditions, will result in doses which are very much smaller than the doses necessary for the health effects displayed in this table. Data on the specific effects are based on studies detailed in the three appendices on human health.

The effects shown in this table are summaries of effects reported at varying doses for tests conducted on laboratory animals and reported from human exposures. Not all effects were seen in all tests, nor with all listed species. Any major effect seen has been noted regardless of the data quality and whether the results were laboratory tests on rats, dogs, rabbits or observations of humans.

Testing protocols for assessing neurologic and immunologic effects have not been established by either the scientific community or the Environmental Protection Agency. In all but a few cases, existing data is inadequate. Sometimes neurologic or immunologic effects are noted in testing for other toxilogical endpoints. The reported effects are shown in the table.

Table IV-17

Quality of Information on 16 Herbicides by Type of Toxicity

Chemical	Systemic	Cancer	Reproductive	Developmental	Neurologic	Immunologic
Amitrole	M	M	I	A	I	I
Asulam	M	A	M	M	I	I
Atrazine	M	M	M	M	M	I
Bromacil	M	M	M	M	I	I
2,4-D	A	M	A	M	A	M
2,4-DP	A	M	M	A	I	I
Dalapon	M	M	I	M	I	I
Dicamba	I	M	M	M	I	I
Diuron	I	I	I	M	I	I
Fosamine	M-I	I	I	I	I	I
Glyphosate	M-I	M	M	A	I	I
Hexazinone	M	A	M	M	I	I
Picloram	A	M	M	M	I	I
Simazine	M	I	M-I	A	I	I
Tebuthiuron	M-I	M	M	M-I	I	I
Triclopyr	M-I	M	M	A	I	I
Diesel Oil	I	M-I	I	M	I	I
Kerosene	I	I	I	M	I	I

Quality of Data:

I = Inadequate information available for evaluating toxicity. There were too few studies of sufficient quality to yield useful or reliable information.

M-I= Some useable information exists for evaluating toxicity for the given health effect. There were some studies of marginal quality that provided useful information, but studies were inconsistent and some contained flaws. It is likely that new studies would change estimates of health effects.

M = Marginal but useable information available for evaluating toxicity. There were studies of adequate quality and results did not vary greatly, but more information would increase reliability. Although new studies may change estimates of health effects, the results are considered moderately reliable.

A = Adequate information is available. Studies are of sufficient quality and quantity that estimates of human health are considered reliable. New studies are unlikely to change estimates of health effects.

Based on information supplied by EPA, this risk assessment assumes that synergism would not likely occur between the active and inert ingredients except in the formulations that use kerosene. Given, as noted above, that the cancer potency of kerosene is about 6,000 time lower than the 2,4-D cancer potency, it would not add significantly to the potency of the 2,4-D formulation or mixtures.

Herbicide Exposure

Two human populations, workers and the general public, may be exposed during herbicide applications. Worker personnel, such as mixer-loaders and backpack sprayers, are directly involved in treatment operations. Members of the public, including forest visitors and nearby residents, may be exposed to herbicide drift, to vegetation with herbicide residues, and to accidental spraying. They also could eat food or drink water containing a herbicide residues. Figure IV-14 indicates examples of routes of exposure to herbicides. Table IV-18 lists the routes of exposure for which doses were estimated in the quantitative risk assessment.

The herbicide exposure analysis determined the extent of exposures and resultant doses to workers and the public from routine operations and accidents under the Forest Service's proposed program. Because no analysis could consider all the possible circumstances of herbicide spraying, scenarios were used that were simplified descriptions of spraying operations and potential routes of human exposure.

The scenario estimates were designed to indicate what could possibly happen under specified cicumstances. They do not reflect what will happen in the actual programs because worker restrictions and precautions should reduce most of their exposures, and members of the public should not be exposed at all.

Four scenarios (helicopter, truck, backpack, and hand application) were used to estimate realistic worker doses in routine operations (routine-realistic scenarios). Four additional scenarios with the same methods of application were used to estimate the highest doses workers might get in routine operations (routine-worst case scenarios). The worker dose estimates were derived from actual worker field study data of 2,4-D doses found by urine analysis. These studies showed that inhalation exposure was a negligible contributor to a worker's total dose; therefore, no separate analysis of worker inhalation doses was conducted. Scenario dose estimates were adjusted for hours worked, application rate, and the different skin penetration rates of the other herbicides.

Three of the four routine-realistic scenarios (helicopter, truck, and backpack spraying) were used to estimate public doses. The same three routine-worst case scenarios were used to estimate the highest likely public doses. Because no studies of public exposure comparable to the worker studies were available, the public's doses were estimated by a mathematical accounting (modeling) of the movement and fate of each herbicide in the area of spraying to estimate exposure levels on their skin, on their food, and in their drinking water. As in the case of workers, inhalation exposures of the public were considered negligible and were not estimated.

Dermal doses from the smaller herbicide spray droplets drifting offsite and depositing on a person's skin or from brushing up against vegetation with drift residues were estimated. Doses to a person drinking water with herbicide residues and eating berries, deer meat, game birds, garden vegetables, and fish containing herbicide residues also were calculated. It should be noted that these are one-time or once-per-year doses for the public that will be compared (by computing a margin of safety) to no-observed-effect levels (NOELs) derived from lifetime animal studies. This tends to greatly overestimate the risk from these rare events.

Estimated doses varied depending on the pesticide used, level of work, and which population (workers or the public) were considered. To put these doses into perspective, a person who takes a single vitamin C tablet of 250 mg each day and who weighs 70 kg (about 154 pounds) would be getting a dose of 3.6 mg/kg/day. If the person took a vitamin C tablet only once during his/her entire lifetime and lived 70 years, his/her average daily dose over those 70 years would be about 0.00015 mg/kg/day from that one tablet.

Realistic public doses ranged from 0.000001 mg/kg to 0.003 mg/kg. Worst case public doses in routine operations ranged from 0.000002 mg/kg to 0.25 mg/kg. Worker doses in routine operations ranged up to 0.6 mg/kg for backpack applicators for the realistic scenarios and up to 7.4 mg/kg for backpack applicators in the worst case scenarios. Doses to the public in accidents were as high as 4.4 mg/kg from a truck spill into a pond. Accidental doses to workers ranged up to 240 mg/kg for a spill of concentrate on their skin. Appendix D contains a full listing of doses for all scenarios.

Quality of the Scientific Data on Herbicides

To summarize, the quality of toxicity data for drawing inferences about possible human health effects are adequate for 2,4-D, 2,4-DP, and picloram. Studies are of sufficient quality and quantity that estimates of human health are considered reliable. New studies are unlikely to change estimates of health effects.

The quality of data for amitrole, asulam, atrazine, bromacil, dalapon, glyphosate, hexazinone, and simazine is marginal and has useable information for evaluating toxicity. There were studies of adequate quality and results did not vary greatly, but more information would increase reliability. Although new studies may change estimates of health effects, the results are considered moderately reliable.

The quality of data for dicamba, tebuthiuron, and triclopyr was marginal to inadequate. There were some studies of marginal quality that provided useful information, but studies were inconsistent and some contained flaws. It is likely that new studies would change estimates of health effects. Very cautious asumptions were made in characterizing risk.

Figure IV-9

Routes of Exposure to Herbicides in Spraying Operations

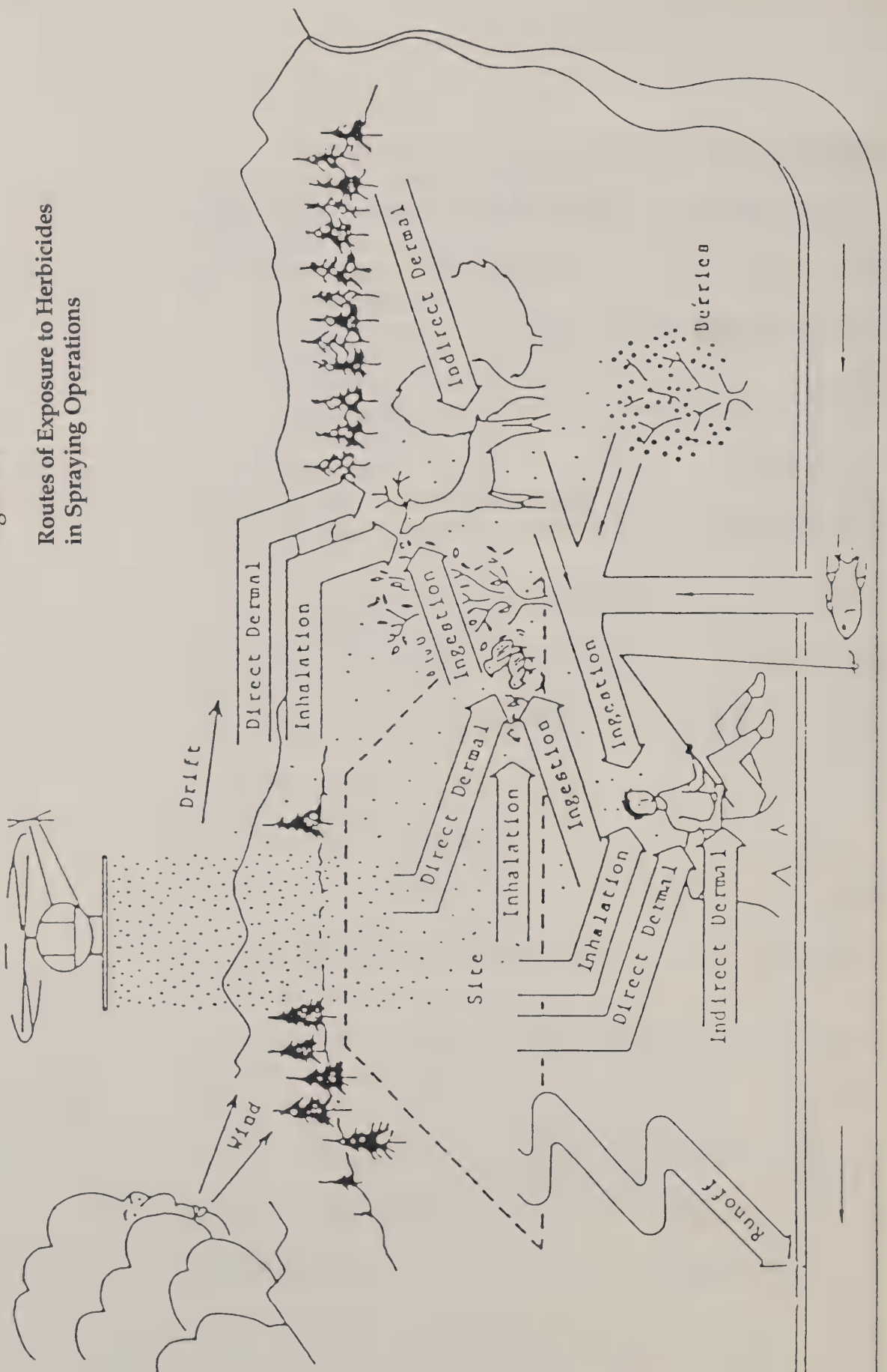


Table IV-18

Routes of Exposure Considered in This Risk Assessment

	Doses from Direct Exposure	Doses from Indirect Exposure
Routine		
Workers	Total dose (based on field studies)	Dermal dose from reentry to treated area (based on field data)
General Public	Dermal dose[a] from drift (based on modeling)	Dermal dose from vegetation contact in drift area and from consuming food with residues (based on modeling)
Accidental		
Spraying	Dermal dose[a] to member of public directly sprayed (based on modeling)	Worker vegetation contact dose from reentry to treated area immediately after spraying. Dose to member of public who walks through treated area and who eats directly sprayed food items[b] (based on modeling)
Spills	Worker dermal dose from spill of concentrate or mixture on skin (based on modeling)	Dose to member of public from drinking water contaminated by an herbicide spill (based on modeling)

[a] Inhalation is negligible based on field study data.

[b] Diet items include garden vegetables, berries, deer meat, game bird meat, and fish.

Data was inadequate for diuron and fosamine. There were too few studies of sufficient information to yield useful or reliable information. More detailed information on the quality of data for all herbicides is shown in Table IV-17.

Risk of Herbicides

Risks to humans exposed to the 16 herbicides were quantified by comparing the scenario dose estimates with the doses from the toxicity tests on laboratory animals. Systemic effects were evaluated based on the lowest systemic NOEL. Reproductive effects were evaluated based on the lowest maternal, fetotoxic, or teratogenic NOEL.

For doses that are not likely to occur more than once, such as those received by workers spilling spray mix over their entire upper body, a dose estimate that exceeds the NOEL does not necessarily lead to the conclusion that there will be toxic effects. All the NOELs in this risk analysis are based on (or take into account) long-term exposure.

A worst case analysis of cancer risk was conducted for the herbicides for which there are positive cancer studies (amitrole, asulam, atrazine, bromacil, and 2,4-DP) and for herbicides for which there is uncertainty or scientific controversy regarding their carcinogenic potential (2,4-D, glyphosate, and picloram). The risk of cancer is calculated for an individual by multiplying estimates of lifetime dose over a 70-year period by the herbicide's cancer potency, as discussed in Appendix D. The risk of these herbicides causing mutations is qualitative rather than quantitative, with a statement of the probable risk based on the weight-of-evidence of mutagenicity assays and carcinogenicity tests, as discussed in Appendix D.

Risk Of General Systemic and Reproductive Effects

Risk to the Public

As indicated previously, we have explored the question of what could happen under unusual circumstances by developing hypothetical exposure scenarios. These scenarios do not represent risks that we actually expect to occur. Most members of the public would be at no risk at all because they are not in the immediate vicinity where herbicides are used. The only members of the public who are at risk are those who are actually exposed to herbicides as a result of being in an area where herbicides are being, or have been recently, applied, such as timber harvest units, or adjacent to roadsides where vegetation has been sprayed, or as the result of accidents.

Tables IV-19 and IV-20 summarize the results of the detailed analysis of risk to the public shown in full detail in Appendices D and H. These tables show the probability of receiving a toxic dose using margins of safety which are based on the lowest doses that have no effects on animals. The categories for exposure and associated margins of safety are as follows:

Probability of Exposure to a Toxic Concentration	**Calculated Margin of Safety**
High	Less than 10
Moderate	Between 10 and 100
Low	Between 100 and 1,000
Negligible	Greater than 1,000

Table IV-21 identifies human health effects of concern and the measures that will be taken to mitigate the concern.

The four compounds in major use are 2,4-D, glyphosate, picloram, and triclopyr. Glyphosate and picloram present a low risk of systemic health effect under all scenarios of routine operations. Triclopyr and 2,4-D pose a moderate risk in these situations. Under accidental conditions, 2,4-D, picloram, and triclopyr have a high probability of effects on general health, while glyphosate poses a moderate risk. This type of physiological effect probably would not be detected by most individuals, but might be experienced as sickness by more sensitive members of the population.

Under routine operations, none of these four herbicides have a high potential for causing adverse effects to the reproductive system as to the developing fetus. Under accidental conditions, 2,4-D, glyphosate, and triclopyr have a high potential for causing these effects, picloram poses a moderate risk. The importance of taking adequate precautions to prevent members of the public from accidental exposures from aerial applications of pesticides is confirmed by this analysis.

Of the 12 herbicides that have been used less extensively in the past, the Forest Service has decided to suspend the use of three: amitrole, fosamine, and diuron. Amitrole is suspended from use primarily because there is evidence of strong cancer potency, and because it appears to be able to negatively affect the developing fetus. Fosamine and diuron are suspended because there is not sufficient information available to evaluate cancer-causing potential in animals or humans for either compound. Reevaluation will occur when new information is developed.

Use of the other 12 herbicides in routine operations, presents high risks from atrazine and amitrole for systemic effects and from atrazine

Table IV-19

Estimates of Effects on General Health for Member of Public if Exposed to Herbicides Used in Routine Operations or from a Large Spill[a]

Herbicide	Probability of Receiving a Toxic Dose if Exposed During: Routine Operations	A Large Spill
2,4-D	Moderate	High
Glyphosate	Low	Moderate
Picloram	Low	High
Triclopyr	Moderate	High
Dalapon	Moderate	High
Atrazine	High	High
2,4-DP	Low	High
Hexazinone	Low	High
Fosamine	Insufficient Information	
Dicamba	Low	Moderate
Asulam	Low	Moderate
Tebuthiuron	Moderate	High
Diuron	Insufficient Information	
Simazine	Moderate	High
Bromacil	Low	High
Amitrole	High	High
Diesel oil	Insufficient Information	
Kerosene	Insufficient Information	

[a] Based on criteria developed by the USDA Food Safety Inspection Service in the compound evaluation system (see USDA 1988). The categories for exposure and associated margins of safety are:

Probability of exposure to a toxic concentration	Calculated margin of safety
High	Less than 10
Moderate	Between 10 and 100
Low	Between 100 and 1,000
Negligible	Greater than 1,000

See Appendices D and H for complete information.

Table IV-20

Estimates of Effects on Reproductive System for Member of Public if Exposed to Herbicides Used in Routine Operations or from a Large Spill[a]

Herbicide	Probability of Receiving a Dose That May Cause Reproductive or Developmental Effects if Exposed During: Routine Operations	A Large Spill
2,4-D	Moderate	High
Glyphosate	Moderate	High
Picloram	Negligible	Moderate
Triclopyr	Moderate	High
Dalapon	Insufficient Information	
Atrazine	High	High
2, 4-DP	Low	High
Hexazinone	Low	Moderate
Fosamine	Insufficient Information	
Dicamba	Moderate	High
Asulam	Low	Moderate
Tebuthiuron	Moderate	High
Diuron	Insufficient Information	
Simazine	Moderate	High
Bromacil	Negligible	Moderate
Amitrole	Insufficient Information	
Diesel oil	Insufficient Information	
Kerosene	Insufficient Information	

Based on criteria developed by the USDA Food Safety Inspection Service in the compound evaluation system (see USDA 1988). The categories for exposure and associated margins of safety are:

Probability of exposure to a toxic concentration	Calculated margin of safety
High	Less than 10
Moderate	Between 10 and 100
Low	Between 100 and 1,000
Negligible	Greater than 1,000

See Appendices D and H for complete information.

Table IV-21

Summary of Concerns Arising from the Herbicide Risk Assessment and Action that Will Be Taken to Address Those Concerns

Human Health Effects	Mitigating Measures
Strong evidence from animal studies that amitrole causes cancer and could possibly affect fetal health; high risk under routine scenario for general health and reproductive and fetal health effects.	Suspend amitrole from use.
No information on cancer causing potential of fosamine.	Suspend fosamine from use until information is developed.
No information on cancer causing potential of diuron.	Suspend diuron from use until information is developed.
Public Margins of Safety less than 100 in realistic aerial spraying scenarios for atrazine.	Do not apply atrazine aerially.
Public Margins of Safety less than 100 in worst-case aerial spraying for range management scenarios using 2,4-D, dalapon, dicamba, glyphosate, simazine, tebuthiuron, and triclopyr.	Take all precautions to ensure public is not exposed in range managemnt spraying (public notice posting, avoid areas with residences).
Moderate or high probability of workers receiving a toxic dose if herbicides are spilled on skin during: 2,4-D aerial, backpack and hack and squirt operations; Triclopyr aerial, backpack and hack and squirt; Dalapon backpack; Atrazine aerial and backpack; Simazine aerial and backpack; Bromacil: backpack (high) ROW and hack and squirt; and Amitrole aerial and backpack.	Require wearing of protective clothing for all Forest Service and contract mixer loaders, backpack applicators, and all hack and squirt applicators. Require written certification that protective clothing was worn and the names of workers involved for both Forest Service and contract workers. Conduct field exposure sampling on 10% of projects for which workers may have moderate probability of receiving a toxic dose.

Any potential adverse human health effects.	Worker Exposure Monitoring: For all contract and Forest Service workers involved in pesticide application programs, keep a written record of names and jobs of individuals involved, chemical used, acreage treated, use of protective clothing and equipment, duration of exposure, and method of application. Institute a regional database for tracking the information on an individual's involvement in herbicide programs. Public Exposure Monitoring: Where a concern exists for public exposures, develop an exposure monitoring plan for the project which is appropriate to the concern, monitoring methods used, and the site. Monitoring may include water monitoring, monitoring of drift with spray cards, or taking soil or plant samples. Risk Management: For each vegetation management project develop a risk management plan that includes a project risk plan, environmental monitoring plan, spill incidence response plan, prescribed buring plan, and herbicide application plan.
Insufficient information on reproductive or developmental effects for dalapon.	Public: Eliminate the use of dalapon in roadside vegetation management or other uses where members of the public could be exposed to dalapon either through routine operations or accidents. Workers: Do not use female Forest Service or contract workers in any dalapon applications.
High probability for the public of receiving a toxic dose if exposed to amitrole during routine operations. A probable human carcinogen, high cancer potency.	Eliminate amitrole from the program. Mitigation measures may not be consistently effective in managing the risks.

Moderate to high probability of the public receiving toxic doses from a large accidental spill for most herbicides.	Constantly monitor location and condition of all tankers or trucks carrying herbicides for Forest Service operations. Prepare emergency spill plans including public notification for all projects as part of the project risk management plans.
Moderate probability of the public receiving a toxic dose of 2,4-D, dalapon, dicamba, glyphosate, simazine, tebuthiuron or triclopyr if exposed in a large aerial range management spraying project.	Take all precautions to ensure the public is not in the vicinity of the sprayed area including posting public notices. Avoid treatment of areas with nearby residences.
High probability of the public receiving a toxic dose of atrazine from a realistic aerial spraying.	Do not apply atrazine aerially.
Moderate probability of backpack applicators and hack-and-squirt applicators receiving a dose that may cause reproductive or developmental effects in operations for 2,4-D, glyphosate, dicamba, tebuthiuron, triclopyr, simazine, and bromacil. High probability of their receiving a dose that may cause these effects for atrazine.	Do not use contract or Forest Service female workers in backpack or hack-and-squirt applications of any of the listed herbicides.
Moderate-to-high probability of mixer/loader workers receiving a dose of atrazine or simazine that may cause reproductive or developmental effects.	Do not use female workers as mixers or loaders in atrazine or simazine applications.
Public health effects from exposure to smoke from prescribed burning.	Follow Oregon and Washington State smoke management plans.
Unknown health effects of brown and burning (using herbicides as a desiccant to facilitate prescribed burning).	Do not prescribe burn any areas within one year of treatment with pesticides.

Insufficient information to assess human health effects of kerosene and diesel oil.	Diesel oil will not be used in herbicide applications except as an adjunct (not to exceed 5% o the spray mixture). Kerosene will not be used in herbicide applications except as an inert ingredient in the esther formulation of triclopyr. A long history of using diesel oil and kerosene (in a variety of operations such as slash burning, fueling equipment and as a cleaning solvent) has not revealed acute human health effects. However, there is insufficient information available to asess long-term health effects. Care will be taken to avoid skin contact with diesel oil and kerosene. If contact does occur, affected skin areas should be promptly washed with soap and water, and soaked clothing will be changed.
Mixtures	All contract and Forest Service workers directly involved in applying herbicide mixtures must wear protective clothing, and follow the most stringent mitigation measures of any constituent.
Variable or unknown health effects of inert ingredients in herbicide formulations.	Use herbicide formulations that are known to contain only inerts on EPA inerts lists 3 and 4 (inerts of lower priority for testing and inerts generally recognized as safe). See Appendix J. For formulations that contain inerts on lists 1 or 2 (inerts of high priority for testing and inerts that have been shown to be hazardous), use formulations only when inerts are known and human health risks have been fully assessed according to the standards established in this EIS and incorporated in NEPA decision-making.

Effects on hyper-sensitive individuals.	Public notification for all applications that requests that people who know or suspect that they are hypersensitive contact the Forest Service to determine appropriate risk management measures. Institute a self-screening program to identify and remove sensitive individuals from herbicide projects. Both contract and Forest Service Workers that have knowledge of hypersensitivity not to be used on a project, on-the-job, or workers who display symptoms that may indicate hypersensitivity will not be used on application projects.
Cumulative herbicide cancer risk over a lifetime.	Monitor contract or Forest Service workers to identify those whose cumulative exposures due to herbicides lead to cancer risks that approach 1 in 1,000,000 (background risk) and remove those individuals from application projects.
Diuron: Limited data suggest that Diuron has relatively high toxicity and high exposure for backpack application. In addition, there is insufficient information for full toxicologic evaluation.	Eliminate diuron from the Region's program.
Fosamine: There is insufficient information for conducting a full toxicologic evaluation.	Eliminate fosamine from the Region's program.

for reproductive effects. Dalapon, tebuthiuron, and simazine pose moderate risks of both systemic and reproductive effects, and dicamba presents a moderate risk of reproductive effects.

The remaining herbicides pose low or negligible risks under routine operations. Accidental scenarios again show that the risk increases, especially for bromacil, hexazinone, amitrole, and 2,4-DP. For 2,4-DP, the increase in risk borders on the high category (also see Appendix D). Because there is an indication in a good animal model (the rabbit) for humans that 2,4-DP might cause birth defects, it will have restrictions on its use until further study shows the restrictions to be unwarranted. Because of the conservatism of the analysis, repeated accidental exposure would be necessary to develop a serious situation of risk. Once again, the importance of accident prevention is emphasized.

The highest estimated dose to the public for most of the herbicides, major and minor use, comes in the scenario where someone drinks water from a pond, unaware that it has been seriously contaminated by herbicide concentrate from a truck accident (Appendix D). Consumption of water from this contaminated pond would present a sometimes moderate, usually high, risk for systemic and reproductive effects. Therefore, it is important to have an herbicide emergency spill notification system. The analysis shows that prompt restriction of access should prevent serious poisoning incidents.

Risk to Workers

Tables IV-22 and IV-23 summarize the results of the risk assessment for workers for general health, reproductive fitness, and/or fetal health if the worker is pregnant. Table IV-21 identifies human health effects of concern and the measures that will be taken to mitigate the concern. All workers in these analyses were not wearing protective clothing. An analysis of risk with protective clothing was also undertaken and is shown in Appendix D which also shows in greater quantitative detail the risks summarized here.

Atrazine presents a significant risk of reproductive or developmental effects to backpack sprayers and aerial mixer/loaders. Use of atrazine, 2,4-D, and bromacil is also associated with significant risk to the general health of backpack sprayers. In general, backpack spraying is associated with the greatest risk, followed by aerial mixer/loaders and hack-and-squirt workers. All other categories of workers have less risk according to this analysis. (see Appendix D)

The scenarios and doses estimated in the exposure assessment were designed with very conservative assumptions that tend to overstate risk. Different scenarios with different assumptions could change the risk assessment. However, taken together with the analysis of risk with protective clothing, the risk assessment emphasizes the importance of attention to worker safety training, use of protective clothing, emphasis on good personal hygienic habits in the workplace and in the field, and carefully defined procedures to minimize spills.

The risk from accidental spills of concentrated herbicides on the skin of unprotected workers is estimated in Appendix D. The estimated doses shown in Appendix D are usually greater than 1 percent and often greater than 10 percent of the LD50 are likely to be poisonous and possibly fatal to humans.

Cancer Risk

A worst case analysis of cancer risk was done only for those herbicides showing positive evidence (amitrole) or suggestive evidence (asulam, atrazine;, bromacil, 2,4-D, 2,4-DP, glyphosate, and picloram) of causing tumor growth in the laboratory. For the remaining herbicides, there is either no evidence to suggest that they could cause cancer, or there is not sufficient data to draw conclusions about their cancer causing potential.

Cancer Risk to the Public

Cancer risk for the general public was calculated for a single exposure, and also for 30 exposures over a lifetime. Of the eight chemicals with positive oncogenic studies the greatest risks are for amitrole. In the highest exposure situation (the large aerial scenario), the maximum risk of cancer for a single exposure is less than 7 in 10 million (for a person eating vegetables from near the spray site).

Even when several routes of exposure are added for the example (a nearby resident), the resulting risk for a single incident is still less than 2 in 1 million. The cumulative risk resulting from several exposures of this magnitude would be the sum of the risks for each exposure. If 30 routine-worst case exposures are experienced, the cumulative risk would be less than 3 in 10,000. Exposures in the routine-realistic cases lead to much lower risk. The risk of cancer resulting from doses from any of the routes of exposure in the typical aerial spraying scenario is less than 2 in 100,000, even for amitrole. Cancer risks for the other chemicals are far less. The risk for glyphosate is never greater than 2 in 1 billion. For 2,4-D, 2,4-DP, asulam, and picloram, none of the routes of exposure in any scenario results in a cancer risk greater than about 2 in 10 million, per exposure. The highest risk

of cancer to the public from bromacil usage is from backpack spraying of large areas because bromacil is not aerially applied in the forests of Region 6. The risk from any route of exposure is less than 4 in 100 million.

Cancer Risk to Workers

Cancer risk to workers was calculated for an expected case assuming 5 years of employment in herbicide application and an average number of days of spraying per year. The average number of exposures per lifetime was estimated to range from 30 to 70. The risk was calculated in the extreme cases assuming 30 years of employment and a total of 288 to 480 exposures. It is very unlikely that a worker would apply herbicides on the number of days assumed in the worst case. The risks for each herbicide were calculated assuming that only that herbicide was used.

The highest risks for workers involve atrazine use. The lifetime cancer risk to a backpack sprayer using only atrazine is about 2 in 10,000 in the expected case. In the worst case, the risk is greater than 1 in 1,000.

The risk is much less for the other chemicals. The highest risk for 2,4-D is about 1 in 100,000 for backpack spraying in the realistic case, and in the extreme case, the greatest risk is about 1 in 10,000. The risk is somewhat greater for amitrole: as high as 7 in 100,000 for the realistic backpack exposure. Workers using asulam in the extreme case have a lifetime cancer risk of less than 6 in 10,000 for all worker categories. Workers using bromacil have a risk of less than 8 in 10,000 in the worst case. The cancer risk from picloram or glyphosate use is even less for all worker categories, never exceeding 3 in 10 million in the expected case.

Risk Of Other Health Effects

Heritable Mutations

As discussed previously, no human studies are available that associate any of the herbicides with heritable mutations. Furthermore, no risk assessments that quantify the probability of mutations from the herbicides are available in the literature or from EPA. While laboratory studies constitute the best available information on mutagenic potential, no acceptable mutagenicity test exists for some of the herbicides. For these herbicides, a worst case assumption is made that the herbicides have the potential to cause mutations in humans. In these cases the results of carcinogenicity tests or cancer risk assessments can be used to estimate the worst case risk for nonthreshold toxicity.

Using the results of carcinogenicity tests or cancer risk assessments is reasonable because mutagenicity and carcinogenicity both follow similar mechanistic steps for genetic toxicity.

The basis for this assumption is that both mutagens and at least primary carcinogens react with DNA to form a mutation or DNA lesion affecting a particular gene or set of genes. The genetic lesions then require specific metabolic processes to occur, or the cell must divide, to insert the lesion into the cell's genetic code.

For these reasons, the quantitative risk of cancer provides a worst-case approximation to heritable mutations because cancer involves many types of cells, whereas heritable mutations involve only germinal (reproductive) cells.

Asulam and glyphosate tested negative for mutagenicity in all assays conducted, and thus can be considered to pose no mutagenic risk. Hexazinone and simazine were nonmutagenic in most assays conducted and were nononcogenic in all of the carcinogenicity tests performed; therefore, it can be assumed that their germ cell mutagenic risk is slight to negligible. Dicamba was nonmutagenic in most of the assays performed, and no oncogencity was found in long-term studies. Because of mixed results, dicamba is considered a mutagen in the worst case analysis, but the germ cell mutagenic hazard would be extremely limited. based on the bulk of negative results. Bromacil tested positive in one of two oncogenic studies. The risk of heritable mutations from the chemical should be no greater than the estimates of cancer risk.

Atrazine tested positive for mutagenicity in 15 of 33 assays. The worst case assumption is that atrazine is mutagenic. However, many of the positive results were achieved through tests that may not be relevant to evaluating mutagenic risk in humans. Some positive results in rodents were also achieved, but these in vivo responses were only observed at levels greater than 1,500 mg/kg body weight. These are exceptionally high levels and suggest that the degree of germ cell risk would be lower than the risk for cancer and that the DNA change from low levels of atrazine would be minimal. The worst case estimate for atrazine mutagenic effects would be no greater than the risk of cancer.

Amitrole was nonmutagenic in 56 microbial gene mutation tests. The results of two tests that were positive are considered of questionable validity by EPA, and overall, it is considered to pose no potential for heritable mutations. The worst case estimate for amitrole mutagenic effects would be the risk of cancer.

Table IV-22

Probability of Receiving a Dose that May Cause Effects on General Health (Systemic Effects) of Workers Exposed to Herbicides During Routine Operations[a,b]

Herbicide	Aerial Mixer/Loader	Backpack Sprayer	R/O/W Mixer/Loader	Hack-&-Squirt
2,4-D	Moderate	High	Moderate	Moderate
Glyphosate	Low	Low	Negligible	N/A
Picloram	Negligible	Negligible	Negligible	Negligible
Triclopyr	Low	Moderate	Negligible	Low
Dalapon	Moderate	Moderate	Low	N/A
Atrazine	High	High	Moderate	N/A
2,4-DP	Negligible	Negligible	Negligible	Negligible
Hexazinone	Low	Moderate	Negligible	N/A
Fosamine	———	Insufficient Information	———	
Dicamba	Low	Low	Negligible	Low
Asulam	Low	Low	Negligible	N/A
Tebuthiuron	Low	Moderate	Negligible	N/A
Diuron	———	Insufficient Information	———	
Simazine	Moderate	Moderate	Low	N/A
Bromacil	N/A	High	Low	Low
Amitrole	Moderate	High	Low	Moderate
Diesel Oil[c]	———	Insufficient Information	———	
Kerosene[d]	———	Insufficient Information	———	

[a] Based on historical data of workers not wearing protective clothing.

[b] Based on criteria developed by the USDA Food Safety Inspection Service in the compound evaluation system (see USDA 1988). The categories for exposure and associated margins of safety are:

Probability of exposure to a toxic concentration	Calculated margin of safety
High	Less than 10
Moderate	Between 10 and 100
Low	Between 100 and 1,000
Negligible	Greater than 1,000

See Appendices D and H for complete information.

[c] Herbicide carrier

[d] Formulation inert ingredient

Table IV-23

Probability of Exposure to a Toxic Concentration for Reproductive or Developmental Effects in Workers During Routine Operations[a]

Herbicide	Aerial Mixer/Loader	Backpack Sprayer	R/O/W Mixer/Loader	Hack-&-Squirt
2,4-D	Low	Moderate	Low	Moderate
Glyphosate	Low	Moderate	Negligible	N/A
Picloram	Negligible	Negligible	Negligible	Negligible
Tricolopyr	Low	Moderate	Negligible	Low
Dalapon	———	Insufficient Information	———	
Atrazine	High	High	Moderate	N/A
2,4-DP	Negligible	Negligible	Negligible	Negligible
Hexazinone	Low	Low	Negligible	N/A
Fosamine	———	Insufficient Information	———	
Dicamba	Low	Moderate	Negligible	Moderate
Asulam	Low	Low	Negligible	N/A
Tebuthiuron	Low	Moderate	Negligible	N/A
Diuron	———	Insufficient Information	———	
Simazine	Moderate	Moderate	Low	N/A
Bromacil	N/A	Moderate	Low	Low
Amitrole	———	Insufficient Information	———	
Diesel Oil[c]	———	Insufficient Information	———	
Kerosene[d]	———	Insufficient Information	———	

[a] Based on historical data of workers not wearing protective clothing.

[b] Based on criteria developed by the USDA Food Safety Inspection Service in the compound evaluation system (see USDA 1988). The categories for exposure and associated margins of safety are:

Probability of exposure to a toxic concentration	Calculated margin of safety
High	Less than 10
Moderate	Between 10 and 100
Low	Between 100 and 1,000
Negligible	Greater than 1,000

See Appendices D and H for complete information.

[c] Herbicide carrier

[d] Formulation inert ingredient

For picloram and 2,4-D, studies have indicated positive and negative mutagenic potential. Most picloram tests were negative. About half the 2,4-D assays were positive or weakly positive. A number of comprehensive reviews of the 2,4-D mutagenic data have indicated that it does not pose significant risk of human gene mutations (U.S. Department of Agriculture, 1984b). Based on a worst case estimate, the risk of heritable mutations from these chemicals would be no greater than the estimates of cancer risk.

Mutagenicity tests with 2,4-DP have shown mixed results. 2,4-DP was negative in 3 microbial assays and positive in 3 other assays; therefore, it may have limited genotoxic potential. Based on the limited test data presented in Section 3, one cannot presume mutagenic hazard, because no in vivo or mammalian assays have been conducted. However, the worst case assumption is that 2,4-DP is mutagenic, and the mutagenic risk in the worst case would be no greater than the risk of cancer.

Risk of Synergistic Effects

It is possible that synergistic effects could occur as a result of exposure to two or more of the herbicides considered in this analysis. It is unlikely that synergistic adverse effects could result from exposure to more than one herbicide applied in separate projects. Herbicide residues are not expected to persist from one application to another. The 16 herbicides are known to be rapidly excreted from the body, and public exposures to the herbicides should be low (except for accidents) and should occur only very infrequently.

Simultaneous exposure to more than one chemical is likely in cases where those chemicals are combined in a single spray mixture. Although most vegetation control projects in the Region would involve only a single herbicide, some areas would be treated with a mixture of herbicides, but only mixtures that have been approved for use by the EPA. The EPA guidelines for assessing the risk from exposures to chemical mixtures (EPA, 1986b) recommend using additivity models when little information exists on the toxicity of the mixture and when components of the mixture appear to induce the same toxic effect by the same mode of action;. In these instances synergism is not anticipated to occur.

Effects on Sensitive Individuals

Based on the current state of knowledge, individual susceptibility to the toxic effects of the 16 herbicides cannot be specifically predicted. Safety factors traditionally have been used to account for variations in susceptibility among people. The margin-of-safety approach used in

this risk assessment takes into account much of the variation in human response as discussed earlier by Calabrese (1985). The normal margin-of-safety of 100 for both types of variation is sufficient to ensure that most people will experience no toxic effects. However, unusually sensitive individuals may experience effects even when the margin-of-safety is equal to or greater than 100. For example, there have been a few cases of peripheral neuropathy among the thousands of people exposed over the years to 2,4-D. Sensitive individuals comprise only a fraction of the population at large, and it is not likely that a sensitive individual would be among those few people who might be exposed to any of the Forest Service's applications.

Cumulative Effects

No one individual member of the public is likely to receive repeated exposures to any of the herbicides because of the remoteness of most treatment units, the widely spaced timing of repeated treatments, and the use of a variety of herbicides for different purposes. In addition, the precautions taken by the Forest Service in its treatment operations make any dose at all to the public quite unlikely. This risk assessment used the lowest NOELs found in chronic animal laboratory studies for comparison with estimated human doses. The risk analysis results showed that risks to the public from realistic treatment are high only for amitrole. Risks are low to negligible for the other 15 herbicides. Thus, members of the public could receive doses of these herbicides repeatedly over the years (even though the chance of receiving multiple doses is negligible), and still not suffer toxic effects.

It is the goal of the Forest Service to prevent public exposures. Due to the precautions taken routinely in treatment operations, the likelihood of a member of the public receiving one dose is very low. The chance of receiving multiple doses is extremely low, making the likelihood of cumulative efects negligible.

Conclusions

Two of the herbicides evaluated for program use, duiron and fosamine, had insufficient data to support a toxicological analysis. They should be eliminated from the program. A third herbicide, amitrole, poses unacceptable cancer risks under normal exposures. It also should be eliminated from the program. The remaining herbicides can be used safely in the program with precautions and certain restrictions that are described in the next section on program risks.

Chapter 4
Environmental Consequences

- Costs and Benefits
- Social and Economic Effects

Costs and Benefits

The costs and the benefits of managing vegetation are a very important management concern, and all of the alternatives have important management implications. They are presented in this EIS using the "present net value" calculation.

This information is presented in the section comparing alternatives in Chapter II. Additional information about the data and analyses of costs and benefits are presented in Appendix B.

The only benefits which were dollar-quantified in the analysis were those associated with harvesting timber and providing forage for livestock. The costs which were dollar-quantified in the analysis were those associated with producing timber and forage, plus all other costs significantly affected by vegetation management.

Timber benefits were the equivalent of high bid values (what contractors in the marketplace would pay to build roads, log the timber, haul it off, and leave the site in an acceptable condition). The benefits were based on empirical values over a multi-year period. They reflect adjustments to factor out timber sales which were awarded (through a bidding system), but never logged.

Cost inclusion questions arose during the course of the analysis and were especially of concern during the public comment phase. Representative concerns included, "Were the costs of nutrient replacement included in the analysis?" and "Was the cost of the Cleanup Fund included?"

In brief, almost all of these costs have been included in the analysis.

Costs associated with worker's compensation, worker's insurance, liability insurance, licensing of materials and applicators, and so on are included in the analysis because these costs are included in the costs of the materials and the services when the government purchases them. They are not tracked as explicit line items, but they are nonetheless reflected in the bottom line cost of any activity.

Another important concern was the implication of the possibility (raised by people commenting on the Draft EIS) of future "health alerts" or future causes for concern that ultimately result in claims, litigations, penalties, awards, or compensations.

Those reviewers wanted to know whether estimates of these possible costs have been developed and included in the analysis. Here again, the costs are normally included indirectly, as is done when any manufacturer carries liability insurance in case of a defect in the manufacturing process. The economic analysis includes such costs only indirectly.

Others have noted that the cost of preparing this EIS should be identified as a cost of using herbicides, and that any extra costs involved with notifying the public (of a spray program) should be charged against the appropriate method.

The latter instance is, of course, correct. If, for example, the use of a particular method requires more public involvement efforts, then those extra costs should be credited to the method selected.

However, it would be inappropriate to charge the costs of preparing this EIS against any single method or alternative, as this analysis is being conducted to determine the best way to manage competing and unwanted vegetation—not to justify the use of any particular technique or method.

If in the future, an analysis is performed to determine whether a new technique or method is appropriate, then the cost of that analysis would be properly chargeable to the introduction of that method. In the present context of developing this EIS, however, the analysis is being conducted for all methods, and thus, is the same regardless of the alternative ultimately selected.

Nutrient replacement and similar questions are handled in the economic analysis as they are reflected in timber yields. If a certain practice is expected to cause a falldown in timber yields, that reduction would show up in a reduction in benefits from timber production. In this, as in other areas of the study, economics reflect the physical analysis.

The guiding principle for identifying costs is contained in FSM 1971.4 which states:

> "Limit identification of economic costs to only those costs in the production process up to the point of evaluation or to those costs that influence the values of outputs."

Much of the same information that was used during the Forest planning process was also used during this analysis. In aggregate, it represents the best available, most recent, and most comparable (in

terms of the Region's National Forests) information available. It has also been used to formulate outyear budgets for a number of years.

For individual projects, site-specific analyses will be conducted in accordance with NEPA. At this time, highly localized factors can be reflected.

National Forest Budgets

The alternatives under consideration do not all indicate the same level of management on the National Forests. In some alternatives, output levels might remain virtually unchanged, but costs would go up. The net effect of these differences by alternative is shown in the section comparing alternatives in Chapter II. Forest budget costs are included in the analysis of the effects on the economy.

Forest Service budgets (like the jobs, personal income, and payments to local governments discussed below) are affected more by changes in the allowable sale quantity (ASQ) than by changes in vegetation management practices. Vegetation management is normally a small part of Forest Service activities.

The linkages are discussed in more detail in Appendix B, the comparison by alternatives. See Chapter II for a discussion including a breakout of the budget effects between those associated strictly with vegetation management work and those associated with changes in the allowable sale quantity.

Social and Economic Effects

General

Many of the social effects of these alternatives occur as a result of economic changes in jobs, personal income, or the level of funding for schools and roads. Viewed against a backdrop of overall employment, personal income or payments to local governments, these changes may appear to be quite small. However the changes assume a larger stature and a more personal dimension for those whose livelihoods are affected.

At the risk of oversimplification, some generalizations can be made about the social implications of the alternatives. Of the six issues identified during the scoping process, four relate to social concerns: public health, public participation, social and economic conditions, and interagency coordination.

The Effect of National Changes

Changes in the national demand for forest products will continue to produce changes in local employment patterns (especially in Oregon, with its greater dependency on natural resources and greater National Forest acreage and outputs). Variations in vegetation management practices will have an influence far smaller than that of many other external factors that influence the market for these commodities.

For any alternative but Alternative C, the level of national economic activity, new housing, and consumer optimism have more of an impact on the region's economy and on resource-dependent communities than do variations in vegetation management.

Communities and people in the Region are, and will continue to be, affected by vegetation management on the National Forests. However, those effects are relatively small when viewed against the backdrop of the effects caused by the nation's economy.

For all alternatives (except C) these trends, plus short-term conditions such as interest and employment rates and international trade agreements, have wide-ranging effects of much greater magnitude than the changes considered here.

The Effect of Local Changes

In addition to the large-scale changes overshadowing the effects estimated here, there may be significant project-level decisions which will have economic and social effects. Project-level decisions may have important effects which can not be analyzed critically at the Regional level of analysis. The effects discussed here are aggregated for the entire Region. Local effects may be different from the effects estimated for the Region as a whole.

There is much concern, for instance, that we recognize the difference between jobs provided for local residents rather than nonlocal residents. This is important when considering the potential benefits from employing people in areas where there is chronic underemployment. Where they are issues, such considerations can be analyzed and disclosed in project-level environmental analyses.

Economic Effects of the Alternatives

Although the management of unwanted and competing vegetation is a small part of the total level of activity on National Forests in the Region, it has important implications for the communities within Oregon and Washington.

Perhaps the most visible or trackable effects are those that show up in the local economy. Changes in the management of unwanted vegetation change the work that is done on the National Forests and change the amount of commodities that the Forests can be expected to produce.

The principal measures of annual regional economic effects used here are changes in jobs, changes in personal income, and changes in payments to local governments.

The changes in the total number of jobs and in the total amount of personal income received by people are estimated using the IMPLAN input-output model. A later version of IMPLAN than the one used in this analysis was in the final proofing stages, and was therefore not used in this analysis process.

Some have indicated concern that IMPLAN's technical coefficients may no longer be accurate because of changes in the labor component of lumber and other outputs. That point is addressed in Appendix B.

The jobs and personal income estimated are not just the jobs and personal income directly tied to vegetation management, or even just those jobs directly tied to forestry and forest products. All the jobs (and income that is created, as money from them moves through the economy) are included in these figures.

The figures, then, include the logger, the mill worker, the trucker, the chainsaw retailer, physicians, attorneys, educators, and all others affected directly or indirectly by an increased flow of money into the local economy.

In estimating the effects on employment and personal income, three principal sources of change were identified. They are the amount of permitted livestock grazing; the Forest Service budget; and the amount of timber offered for harvest.

Table IV-24 shows the effects of the alternatives on job opportunities in the Pacific Northwest.

Changes in Personal Income

Changes in total annual personal income reflect this same pattern, as shown in Table IV-25.

A share (usually 25 percent) of gross National Forest receipts is sent to local governments. The money is used to support local roads and schools. The estimate of how these payments would be affected by the alternatives are shown in Table IV-26.

Table IV-24

Changes in Numbers of Jobs in Oregon and Washington[1]

Alternative A	-900	-0.03% of Total Employment
Alternative B	None	Total Employment = 2,827,000[2]
Alternative C	-17,600	-0.62% of Total Employment
Alternative D	-1,800	-0.06% of Total Employment
Alternative E	-800	-0.03% of Total Employment
Alternative F	-2,500	-0.09% of Total Employment
Alternative G	+600	+0.02% of Total Employment
Alternative H[3]	-500	-0.02% of Total Employment

[1] Information was generated using the IMPLAN local economic impact model described in Appendix B. "Jobs" include pemanent and temporary positions, part-time and full-time positions, without discrimination. Figures shown represent average annual conditions over the coming decade. Includes direct, indirect, and induced employment resulting from changes in vegetation management practices, changes in the allowable sale quantity, and changes in livestock grazing. See Appendix B for more details.

[2] See Chapter III, Social and Economic Conditions.

[3] Preferred alternative

Effects on Communities

The economic effects of the alternatives (except for Alternative C) appear relatively small within the context of the entire two-state economy. However, the economic effects tend to be concentrated in rural areas. The rural areas of the two states have the least diversified economies, generally the highest unemployment levels, and the lowest income levels. Their tax bases are small, and they often depend on returns from Forest Service receipts for a significant part of their budgets.

The social changes stemming from changes in the economic vitality of local communities are well documented. Indicators of economic hard times and uncertainty include increased rates of alcoholism, child abuse, family stress, and the decline of local organizations and services.

However, the rates of economic change seen in the alternatives (except for Alternative C) are well within the usual year-to-year variation in employment, income, and payments seen in the Pacific Northwest.

Thus, while the community effects of Alternatives A, D, E, F, and H are not positive ones, they are, on average, significantly less disruptive than other recently experienced changes in the region's communities.

Alternative G does contribute positively through slightly enhanced economic activity, but this change is again minor compared to the normal changes of season and the business cycle. Alternative C does significantly disrupt normal economic activity in the region, and would have corresponding disruptive effects on Pacific Northwest communities.

The economic downturn associated with Alternative C would have major effects on timber dependent economies and communities in the Northwest as well as secondary health effects on families and communities. The emotional strain of unemployment is manifested in child and spouse abuse, alcoholism, and stress-related diseases (Weeks, 1982).

Table IV-25

Changes in Total Annual Personal Income in Oregon and Washington [1]
(In1987 Dollars)

Alternative A	- $22,000,000
Alternative B	-0- [2]
Alternative C	- $432,000,000
Alternative D	- $42,000,000
Alternative E	- $19,000,000
Alternative F	- $63,000,000
Alternative G	+ $15,000,000
Alternative H[3]	- $11,000,000

[1] Information was generated using the IMPLAN local economic impact model, discussed in Appendix B. Figures shown represent average annual conditions over the coming decade. They include direct, indirect, and induced personal income resulting from changes in vegetation management practices, changes in the allowable sale quantity, and changes in livestock grazing. See Apppendix B for details.

[2] No changes are associated with this alternative.

[3] Preferred alternative

Table IV-26

Changes in Annual Payments to Local Governments[1]
(In 1987 Dollars)

Alternative A	- $3,000,000
Alternative B	-0-[2]
Alternative C	- $43,400,000
Alternative D	- $2,900,000
Alternative E	- $2,400,000
Alternative F	- $5,200,000
Alternative G	+ $1,600,000
Alternative H[3]	- $1,000,000

[1] Figures shown represent average annual conditions over the coming decade and may be regarded as coming exclusively from changes in expected timber receipts.

[2] No changes associated with vegetation management practices.

[3] Preferred alternative

Other Social Effects

In addition to the social and community effects that derive from the changes in the local economy, there are social results that come from the decision and the implemented program itself. These include the nature and degree of social conflict generated by the decision and program, and perceptions of the safety and productivity of the National Forests.

Data is not available to accurately estimate these effects from a Region-wide perspective. However, they would be most likely to occur in rural areas and small towns near the National Forests. Increased awareness of vegetation management activities, increased risk of exposure to tool and chemical accidents, and greater personal and community dependence on forest settings and forest products all draw rural attention to vegetation management policies and practices.

Where they arise as issues, they are dimensions that should be considered in the project-level design and its site-specific environmental analysis. Appropriate public participation and other information efforts will greatly mitigate these possibly negative social effects.

Effects on Minorities

The effects on civil rights, including those of minorities and women, is expected to be minimal and not systematic. Where these

issues arise, they will be analyzed in the site-specific environmental analyses and project designs.

Dimensions of special concern include possible damage to sites and plants used in American Indian religious practices, and the safety of field workers using manual, prescribed fire, or backpack methods (as racial and cultural minority groups may be prevalent in these work forces).

The overall economic effects of the alternatives will not affect minority group members in any unique way.

Short-Term Use Versus Long-Term Productivity

"Short-term" uses are generally those that determine the present quality of life for the public. Short-term uses of Forests in the Pacific Northwest Region typically include timber harvest, recreation, livestock grazing, transportation, utility corridors, and wildlife habitat. Decisions about these short-term uses are made through the National Forests Land and Resource Management Plan.

Compared to all of the activities that take place in a Forest, a relatively narrow spectrum of management activities is considered in this EIS. Managing competing and unwanted vegetation helps provide the flow of goods and services associated with the short-term uses of a Forest. The process presented here for managing vegetation—and many of the mitigation measures—are designed to protect the long-term productivity of the land.

"Long-term productivity" refers to the capability of the land to support sound ecosystems producing resources such as forage, timber, wildlife, and water. Management activities associated with short-term uses (for example burning, use of machinery, or removal of woody debris) may reduce the natural productivity of some portions of the National Forests. How much the long-term productivity is reduced is not known because investigations of these effects have only recently begun.

The herbicides examined in the EIS have no long-term effect on long-term productivity. However, it is known that any management activities have the potential to reduce the natural productivity of the land if certain operating guidelines are not followed. Each Forest Plan is developing management standards and guidelines designed specifically to protect long-term productivity. In addition, mitigation measures were developed for those management activities considered in this EIS.

Alternatives A, B, E, F. and H all have the same potential effect on long-term productivity. Other practices will somewhat reduce the

potential productivity on some specific sites.

Alternative G will cause a slight reduction in long-term productivity due to less biomass nutrient cycling (because of removal or burning of most logging slash). Alternatives D and H may have a slight positive effect on long-term productivity, as they will leave plant material on sites, making more nutrients available for cycling.

Unavoidable Adverse Effects

Implementation of any alternative would result in some adverse environmental effects that cannot be avoided. Standards and guidelines from Forest Plans—and mitigating measures developed in this EIS—are intended to keep the extent and duration of these effects within acceptable levels, but adverse effects cannot be completely eliminated.

Because this EIS examines alternative programs for managing competing and unwanted vegetation, including slash, the focus is on how a series of projects conducted over a period of years could affect the environment. From this perspective, there are three areas of potentially significant adverse effects:

- human health risks;
- degradation of air quality from fires; and
- economic effects.

The potential for adverse effects varies with each alternative, and is discussed in detail in this EIS.

Human health risks exist for both workers and the public. Risks that workers face from vegetation management activities that were considered in this EIS include:

- accidents from manual control of vegetation;
- accidents from prescribed burning and wildfire suppression;
- exposure to smoke; and
- exposure to herbicides.

Two groups—forest workers and the public—face exposure to herbicides and fire smoke. Worker exposures are far greater in quantity and duration for both herbicides and smoke, which is why these risks (as a group) are roughly equivalent to the risk to the rest of those affected (the public). Two alternatives have significantly less risk for both groups. Alternative C has the least risk, and Alternative D has the next least risk.

The members of the public who experience risks from herbicides are those who come in direct contact with herbicides. Potential routes of exposure are discussed in the EIS in detail. More numerous are the members of the public who experience exposure to smoke from prescribed fires or wildfires.

Health risks to the public at large are roughly correlated with the overall level of management activity, as are the levels of economic product and efficiency. Alternative C has the least risk, and also has very low present net value (PNV). Alternative D has the next least risk, with much higher present net value.

Alternatives E, B, and G (respectively) yield incremental increases in present net value, for additional increments of risk. Alternatives F and A pose relatively higher risks than other alternatives with similar present net values.

In addition to risks from herbicides and smoke, workers experience risk from accidents using equipment and working in rough terrain. The number of predicted accidents is directly correlated with the number of acres treated by manual means and the number of acres burned.

Alternative C ("no action") has by far the fewest number of accidents; Alternative D has the next fewest. All of the remaining alternatives have considerably more accidents, with Alternatives A and E having the most (due to increased acreages treated by hand in lieu of herbicides).

Because risk is directly correlated to the number of acres treated, risks to both the public and workers generally increase as the level of management activity increases. For Alternatives A and E, more acres are treated by hand. This change in treatment causes some decrease in public risk, and some increase in worker risk from accidents.

The amount of smoke produced from both prescribed burning and wild fires is estimated in this EIS. The section on air quality earlier in this chapter presented the total suspended particulates produced by prescribed fire per year.

Alternatives D and F produce significantly less suspended particulates than the rest of the alternatives, except for Alternative C, which has no slash burning. (However, smoke from wildfires is more dense, and the long-term risk of extensive wildfire is greatest in Alternative C.) All of the alternatives, when applied on a Regional level, meet the requirements of the State Implementation Plans and the State Smoke Management Plans.

There are a variety of economic effects associated with each alternative. One measure is the combined change in direct and indirect jobs in the Northwest. The total employment in Oregon and Washington is approximately three million.

There are no changes in employment for Alternative B. Alternative C reduces employment by about 17,600 jobs. Alternatives D reduces it by about 1,800 jobs, and F reduces employment by about 2,500 jobs. Alternatives A and E reduce employment by 900 and 800 jobs (respectively). Alternative G increases employment by 600 jobs. Alternative H decreases employment by 500 jobs.

There is the potential for additional adverse effects beyond those described above. The following effects were considered. They are not expected to be significant, as standards and guidelines and mitigating measures in the Forest Plans will be applied, as well as the mitigating measures identified in this EIS. The effects are:

1) short-term reduction in air quality from dust, smoke, and engine emissions resulting from vegetation management activities (other than prescribed burning);

2) localized reduction in long-term site productivity from burning of logging slash;

3) acceleration of natural rates of land slides and sediment by soil-disturbing activities associated with the use of heavy equipment for vegetation management projects;

4) a temporary increase in fire hazard from waste material left on the ground during vegetation management activities;

5) contamination of water sources due to increased human use of the Forest;

6) decrease in habitat for wildlife species (dependent on particular plant species and growth stages) due to vegetation management activities; and

7) damage to soils by compaction from heavy equipment used for vegetation management.

Irreversible and Irretrievable Commitments of Resources

Irreversible Resource Commitments

"Irreversible commitments of resources" are actions which change either a nonrenewable resource (such as cultural resources or minerals), or which change a renewable resource to the point that it can only be renewed after 100 years or more.

Measures to protect resources that could be irreversibly affected by other resource uses are being incorporated into the standards and guidelines of the Forest Plans, and have been incorporated in the mitigation measures developed in this EIS. Two major irreversible commitments of resources are associated with the management of competing and unwanted vegetation, including slash burning, in the Pacific Northwest Region.

The use of fossil fuels to manage vegetation is an irreversible resource commitment. Alternatives that treat more acres would cause higher consumption of fossil fuels. Alternative G causes the highest consumption; Alternative C, the least.

Vegetation management activities can cause irreversible losses in soil productivity. If prescribed fires violate the prescription, or if wildfires are severe, they can destroy humus and nutrients and reduce water infiltration. Improper use of machinery can also damage soil productivity through compaction and displacement.

Irretrievable Resource Commitment

An "irretrievable commitment of resources" is the loss of an opportunity for production or use of a renewable resource for a period of time. The difference between levels of services and goods under a given alternative and the higher levels that could be otherwise produced represents an irretrievable commitment of resources.

The difference in output levels is the opportunity cost, or lost production. These commitments are irretrievable because the opportunities are foregone. They are not irreversible, since they can be reversed by changing management direction in the future. Irretrievable resource commitments are summarized below.

Timber management: loss of timber volume production in areas where timber growth is slowed or forestalled by competing vegetation. This occurs to some degree in all alternatives except Alternative G. It is most adverse in Alternative C.

Wildlife: localized changes in populations due to changes in habitat.

Cost-efficiency: loss of cost-efficiency when resource objectives do not maximize the net monetary value. Alternative G has the highest net monetary value.

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List of Preparers

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Forest Service (21+ years):

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And Other Contributors

Literally hundreds of persons both within and outside of the Forest Service contributed in large and small ways to shape this program of vegetation management. Chief among them, providing an unparalleled energy and perspective and support to this outstanding team of resource specialists, is Gary Larson, Group Leader for Vegetation Management (Forest Pest Management) in the Pacific Northwest Region.

Other persons, groups, and organizations contributing effort, ingenuity, patience, or passion to the process of creating the new vegetation program are John Core, Department of Environmental Quality; Mike Axline, Western Natural Resource Law Clinic; Bob Dick, Washington Forest Protection Association, Norma Grier and Mary O'Brien,

Northwest Coalition for Alternatives to Pesticides; Terry Witt and Paulette Pyle, Oregonians for Food and Shelter; Ellen Breiter, private citizen; Duncan Wurm, Washington Friends of Farms and Forests; and Karen Murphy, Western Washington Toxics Coalition.

A number of persons within the Pacific Northwest Region's Regional Office were also of great assistance throughout the process of producing the draft and final environmental impact statements, and throughout our public involvement efforts. These include Denver James, Paul Hansen, Gail Saunders, and Gerry Gause of the Public Affairs Office; Leota Hilbran and Audrey Reddekopp (and their reproduction and mail room staffs) and Ron Cason (contracting) of Administrative Services, and many, many individuals in the Personnel, Engineering, and Management Systems divisions.

Several Forest Supervisors and their staffs provided outstanding support and energy throughout the analysis process. Ron McCormick (Siskiyou National Forest), Doug MacWilliams (Mount Baker-Snoqualmie National Forest), Mike Kerrick (Willamette National Forest), and Tommy Thompson (Siuslaw National Forest) were among the most notable.

We'd also like to acknowledge Regional Forester James F. Torrence and former deputy Regional Forester James C. Space (now Director of Forest Pest Management, Washington Office) for their continuing interest and support.

Respondents

5,238 people responded by letter, coupon, card or petition to the draft version of this Environmental Impact Statement. Because of the number of persons responding, a complete list appears in Appendix I, along with a description of public involvement activities, public comments, and the response of the Forest Service to those comments.

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The above listed publications are available by interlibrary loan from research libraries and community libraries. Three of the many forestry libraries in the Northwest include:

William Jasper Kerr Library, Oregon State University, Corvallis, OR 97331

Forest Resources Library, University of Washington, Seattle, WA 98195. Direct interlibrary loan requests to the Resource Sharing Section, FM-25)

University of Alaska Library, 3211 Providence Drive, Anchorage, AK 99508

Forest Service manuals and handbooks may be viewed at any Forest Service office. Other Forest Service documents are on file with the Vegetation Management Project. Contact: Group Leader for Vegetation Management, Forest Pest Management, USDA Forest Service, Pacific Northwest Region, P.O. Box 3623, Portland, Oregon 97208.

Glossary

Glossary



Absorption -- The taking up of liquids by solids, or the passage of a substance into the tissues of an organism as the result of several processes (diffusion, filtration, or osmosis).

Action threshold -- The level of competion or plant cover that triggers control action. In most cases this level is before unacceptable damage occurs.

Active Ingredient (a.i.) -- The effective part of a pesticide formulation, or the actual amount of the technical material present in the formulation.

Activity-Created Fuels -- Fuels created as a result of a management activity; for example, logging, thinning, and road construction.

Acute Health Effects -- Health effects that are immediate and obvious.

Acute Toxicity -- The potential of a substance to cause injury or illness when given in a single dose or in multiple doses over a period of 24 hours or less. In aquatic studies, exposure to a given concentration for 96 hours or less.

Adsorption -- Adhesion of substances to the surface of solids or liquids. Technically, the attraction of ions of compounds to the surfaces of solids or liquids.

Air Contaminant -- Any substance within the atmosphere that is foreign to the natural atmosphere, or that exceeds natural concentrations of the substance within the atmosphere.

Air Pollution -- The presence in the outdoor atmosphere of substances with characteristics that—in sufficient quantities, persisting over enough time—will (or are likely to) be injurious to human health or welfare; animal or plant life; or property values; or interfere with the enjoyment of life or property. These substances include any dust, fumes, mist, smoke, other particulate matter, vapor, gas, odorous substances, or combinations of these.

Air Quality -- The composition of air with respect to the quantities of pollution it contains. The term is used most frequently in connection with "standards" of maximum acceptable pollutant concentrations. It is also used instead of "air pollution" when referring to programs.

Air Quality-Related Value -- A feature or property of an area that is affected in some way by air pollution. Examples include visibility, odor, flora, fauna, soil, water, geologic features, and cultural resources.

Airshed -- A term denoting a geographical area, which, because of topography, meterology, and climate, shares the same air mass.

Allowable Sale Quantity -- The quantity of timber that may be sold from the area of suitable land covered by the Forest Plan for a time period specified by the plan. This quantity is usually expressed on an annual basis as the "average annual allowable sale quantity."

Ambient Air -- Air encompassing or surrounding a particular region. In particular, it is the portion of the atmosphere (outside buildings) to which the general public has access.

Amenity Values -- An expression of the aspects of pleasantness or desirableness commonly associated with recreation, scenic, or wildlife-related experiences.

Anaerobic -- Lacking in free oxygen.

Anadromous Fish -- Species of fish that hatch in fresh water, mature in the sea, and migrate back into fresh water streams to spawn. Salmon, steelhead, and shad are examples.

Animal Unit -- Considered to be one mature (1,000 lb.) cow or the equivalent, based upon average daily forage consumption of 26 lbs. dry matter per day.

Animal Unit Month (AUM) -- The forage requirement for one month for a 1,000 pound mature animal (cow) or its equivalent (5 sheep).

AUM -- See Animal Unit Month.

Attainment Area -- A geographical area in which the quality of air is better than federal air pollution standards.

Available Land -- Land which has not been administratively or legislatively withdrawn from timber production.

Available Forage -- The amount of forage which may be removed without adversely affecting the vigor of the forage plants. This is normally considered to be about 50 percent of a grass plant.

Available Fuel -- The portion of the total combustible woody material that fire will consume under a given set of burning conditions.



Base Flow -- That portion of the water flowing in a stream that is due to ground water seeping into the channel.

Benefit-Cost Ratio -- A measure of economic efficiency. It is computed by dividing total discounted benefits by total discounted costs.

Big Game -- Large mammals hunted for recreation or meat. In this document, if not otherwise qualified, the term generally refers to elk and deer.

Bioaccumulation -- The uptake and temporary storage of a chemical in animal flesh and organs. Over a period of time, a higher concentration of chemical may be found in the organism than in the environment.

Bioconcentration -- The increase in the concentration of a chemical within organisms as it moves up through the food chain.

Biological Growth Potential -- The average net growth attainable in a fully stocked natural forest stand.

Biomass -- The amount of living and dead vegetative matter in a given area.

Board Foot -- A unit of quantity for lumber equal to the volume of a board 12 inches x 12 inches x 1 inch.

Broadcast Burn -- Allowing a prescribed fire to burn over a designated area within well-defined boundaries for the reduction of fuel hazard, as a silvicultural treatment, or both.



Canopy -- The uppermost spreading, branchy layer of a forest.

CFR -- Code of Federal Regulations.

Chronic Health Effects -- Health effects that may take repeated exposures over a period of months or years before becoming apparent. Chronic health effects may blend into the general health problems of life and never be detected.

Class I Areas -- Any area designated for the most stringent degree of protection from future degradation of air quality. Certain national parks, wilderness areas, and other federal reserves in existence on August 7, 1977 (that exceeded 10,000 acres in size) were designated as mandatory Class I areas by Congress in the Prevention of Significant Deterioration Provisions of the Clean Air Act.

Class II Areas -- Any area cleaner then National Ambient Air Quality Standards, designated for a moderate degree of protection from future air quality degradation. Moderate increases in new pollution may be permitted in Class II areas.

Class III Areas -- Any area cleaner than National Ambient Air Quality Standards, designated for a lesser degree of protection from future air quality degradation. Significant increases in pollution may be permitted in a Class III area.

Class I Stream -- Perennial or intermittent streams (or segments of these) that are direct sources of water for domestic use; are used by large numbers of fish for spawning, rearing or migration; or provide enough water to be considered a major contributor to the quantity of water in a Class I stream.

Class II Stream -- Perennial or intermittent streams (or segments of these)that are used by moderate to significant numbers of fish for spawning, rearing or migration; have a moderate influence on a Class I stream; or provide a major contribution to a Class II stream.

Class III Stream -- All other perennial streams (or segments of these) not meeting the criteria for higher classes.

Class IV Stream -- All other intermittent streams not meeting the criteria for higher classes.

Clean Air Act — As amended in 1977, this act requires all federal agencies to comply with all federal, state, and local air quality regulations.

Clean Air Act (CAA) (42 USC 1857 et seq., 7501 et seq.) -- An act for air pollution prevention and control. Main purposes: 1) to protect and enhance public health and welfare and the productive capacity of the population; 2) to initiate and accelerate a national research and development program to achieve the prevention and control of air pollution; and 3) to provide technical and financial assistance to state and local governments in connection with the development and operation of regional air pollution control programs.

Clearcutting -- Removal of virtually all the trees, large or small, in a timber stand in one cutting operation. Leads to the establishment of an even-aged stand.

Climax -- The culminating stage in plant succession for a given site, where the vegetation has reached a highly stable condition.

CMAI -- See Culmination of Mean Annual Increment.

Commercial Forest Land -- Forest land identified as tentatively suitable for the production of continuous crops of timber, which has not been withdrawn for other purposes.

Commercial Thinning -- Any type of thinning of trees producing merchantable material at least equal to the value of the direct costs of timber harvesting.

Commodity -- A transportable resource product with commercial value; all resource products which are articles of commerce.

Community Types -- A generalized category defined in terms of common plant and animal life. Normally a community type generally contains a number of similar stands of vegetation having a number of animal species in common.

Confine -- When referring to fire, the term means to restrict a wildfire within established boundaries. These boundaries may be determined either prior to the fire, during the fire, or in an Escaped Fire Situation Analysis.

Conflagration -- A large and destructive fire (see Wildfire).

Contain -- When referring to fire, the term means to surround a fire (and any spot fires resulting from it) as needed with a "control line" from which most burnable material has been removed. This "line" is constructed in such a way that it can reasonably be expected to check the fire's spread under prevailing and predicted conditions. The term contain may also refer to a wildfire "contained" by unburnable topographic or geologic features, such as cliffs or talus slopes.

Control -- In wildfire suppression, this term refers to completing the control line around a fire (and any spot fires resulting from it), or around interior "island" areas to be saved. It also means that unburned areas on the fire side of the control line are burned out (if this is needed); and that all hot spots that are immediate threats to the control line have been cooled down.

Correction -- A strategy used in the alternatives that requires a high level of energy and resources to reduce the amount of cover of competing and unwanted vegetation. The objective is to reduce damage resulting from competing vegetation to acceptable levels.

Corridor -- A linear strip of land designated for the present or future location of transportation or utility rights-of-way.

Corridor, Utility -- A strip of land, up to approximately 600 feet in width, designated for the transportation of energy, commodities, or communications. This may be by railroad, state highway, electrical power transmission line (66 KV or more), and oil, gas and coal slurry pipelines (10 inches in diameter and larger). It also refers to telecommunication cable and electronic sites for interstate use.

Corridor, Transportation -- A strip of land of variable width designated to accommodate the clearing, access control, and visual resource limits of a highway or road facility. It may also accommodate one or more linear utilities.

Cost, Fixed -- A cost that will be incurred throughout the planning period affected by the decision in question. (In planning talk, "until the planning horizon".) Fixed costs include fixed ownership requirements, fixed protection, short-term maintenance, and long-term planning and inventory costs.

Cost, Investment -- A cost that is incurred for creating or enhancing capital assets. This includes the costs of administrative or common-use transport facilities, and resource management investments.

Cost, Non-Forest Service -- An investment or operating activity cost paid by cooperators or agencies other than the Forest Service. These investments and activities are part of Forest Service management programs, or contribute to the outputs included in the analysis.

Cost, Operational -- For the National Forest System, this is the cost of activities to plan and manage controlled outputs, and for long-term protection and maintenance of capital assets. For State and Private Forestry and Research, operational costs include program activity costs. They are variable costs.

Cost Plus Net Resource Value Change (C+NVC) -- Cost including both the fixed annual cost for the protection organization (annual fire program budget) and the variable suppression (emergency fire fighting) costs.

NVC is the difference in value of planned resource outputs on an area before and after a fire.

Cost, Variable -- A cost that varies with the level of controlled outputs over the planning period of the decisions in question. (In planning talk, "over the time horizon covered by the planning period or decisions being considered.") Variable costs include investment, operational, and variable general administration costs.

Cover -- Vegetation used by wildlife for protection from predators, to ameliorate conditions of weather, or in which to reproduce. See Hiding Cover; Thermal Cover.

Cover/Forage, Cover-Forage Area Ratio -- The ratio (in percent) of the amount of area in forage condition to that area in cover condition. This criteria is used to judge the potential use of an area by deer and elk.

Crop Tree -- Any tree forming part of the final crop. The term generally refers to a tree (in a young stand) selected for that purpose.

Crown Fire -- A fire that runs through the tops of trees, scrub, or brushwood.

Culmination of Mean Annual Increment (CMAI) -- The age at which the annual increment of growth of a timber stand reaches its maximum.

Cultural Resources -- Buildings, sites, areas, architecture, memorials, and objects having scientific, prehistoric, historic, or social values.

Current Direction -- The existing direction in approved management plans; a continuation of existing policies, standards and guidelines, with the current budget updated for changing costs over time. Also incorporates (to the extent possible) production of current levels and mixes of resource outputs.

D

DBH -- See Diameter at Breast Height.

Demand Schedule -- A schedule of quantities of an output that users are willing to take at a range of prices, at a given time, and conditions of sale.

Departure -- Any timber harvest schedule which does not meet the definition of nondeclining evenflow.

Designated Areas -- Principal population centers or other areas requiring protection under state or federal air quality laws or regulations.

Developed Recreation -- Outdoor recreation requiring significant capital investment in facilities to handle a concentration of visitors on a relatively small area. Examples are ski areas, resorts, and campgrounds.

Diameter at Breast Height (DBH) -- The diameter of a tree 4.5 feet above average ground level, except that in National Forest practice it is measured from the highest ground level. Abbreviated dbh. The additional abbreviations, ob and ib are used to designate whether the diameter refers to the measurement outside or inside the bark.

Discount Rate, Nominal -- Discount rate expressed in terms of current dollars, and thus affected by the rate of inflation.

Discount Rate, Real -- A discount rate adjusted to exclude the effects of inflation.

Dispersed Recreation -- Outdoor recreation in which visitors are diffused over relatively large areas. Any facilities or developments provided are generally designed to provide access or to protect the environment, rather than specifically for the comfort or convenience of people.

Diversity -- The distribution and abundance of different plant and animal communities and species within the area covered by a land and resource management plan.

Dose-Response Assessment -- Determines the probability of the adverse outcome for a given level of exposure.

Drift -- The movement of air-borne particles from the intended contact area to other areas.

E

Ecosystem -- An interacting natural system including all the component organisms together with the abiotic (nonliving) environment.

Efficiency, Economic -- The usefulness of inputs (costs) to produce outputs (benefits) and effects when all costs and benefits that can be identified and valued are included in the computations. Economic efficiency is usually measured using present net value, though use of benefit-cost ratios and rates-of-return may sometimes be appropriate.

Emission -- A byproduct of a mechanical or manufacturing process that is released into the atmosphere.

Empirical Yield Table -- A table (for one or more given species on a given site) showing the progressive development of a timber stand at periodic intervals. The table covers the greater part of the useful life of the stand. It is prepared based on actual average stand conditions.

Endangered Species -- Any species of animal or plant which is in danger of extinction throughout all or a significant portion of its range. Refers to plant or animal species identified by the Secretary of Interior as endangered in accordance with the 1973 Endangered Species Act, as amended.

Environment -- The aggregate of physical, biological, economic, and social factors affecting all organisms in an area.

Environmental Analysis -- An analysis of alternative actions and their predictable short- and long-term environmental effects. The analysis includes physical, biological, economic, social, and environmental design factors and their interactions.

Environmental Assessment -- A concise public document which provides sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement or a Finding of No Significant Impact. It aids in compliance with the National Environmental Policy Act (NEPA) when no Environmental Impact Statement is needed.

Environmental Impact Statement -- A document prepared by a federal agency in which anticipated environmental effects of a planned course of action or development are evaluated.

Environmental Protection Agency (EPA) -- The federal agency with primary responsibility for enforcing environmental regulations.

Ephemeral Stream -- A stream which dries up during part of the year.

Escaped Fire -- A fire which has exceeded (or is anticipated to exceed) preplanned initial action capabilities or the fire management direction.

Evaluation Plantation -- A plantation established to evaluate one or more genetic characteristics, whether of individual trees or their parents.

Even-Age Management -- The application of a combination of actions designed to create of stands in which trees of essentially the same age grow together. Managed even-aged forests are characterized by distribution of stands of varying ages (and therefore tree sizes) throughout the forest area. The difference in age between trees forming the main canopy level of a stand usually does not exceed 20 percent of the age of the stand at harvest rotation age. Regeneration in a particular stand is obtained during a short period at or near the time that the stand has reached the desired age or size for regeneration and is harvested. Clearcut, shelterwood, or seed tree cutting methods produce even-aged stands.

Evenflow -- See Nondeclining Evenflow.

Exposure Assessment -- Determines the level of exposure for a given agency policy or activity.



Fine Particulate Matter -- General term refering to particulate matter less than about 10 microns in diameter.

Fire-Dependent Ecosystem -- Ecosystems that require periodic disturbances by fire to maintain their characteristic composition and structure.

Fire Intensity Level -- A measure of heat released over time by the flaming front of a fire, indicated by flame length.

Fire Management Direction -- Fire management standards, guidelines, and practices based upon land and resource management objectives. Fire management direction is used to define the kind, level, and timing of fire protection and use activities, including appropriate suppression strategies. The purpose of this direction is to efficiently meet management objectives (for each program) for the range of expected fire behavior conditions.

Fire Regime -- Fire's effects on an ecosystem depend upon fire type, frequency, duration, severity, and size. These five items define the characteristic fire regime of an ecosystem.

Fire Risk -- Potential for a fire start, natural or human-caused.

Firing Method -- Equipment or means of igniting a fire. Examples include fusee, match, drip torch, and aerial drip torch.

Firing Technique -- A pattern of ignition of an area that causes the fire to burn in a prescribed manner. Examples include heading or backing fires, spot fires, strip-head-fires, and ring fires.

First-Order Stream -- A headwater stream with no tributaries. Two first-order streams combine to form a second-order stream; two second-order streams combine to form a third-order stream; etc.

Floodplain -- The lowland and relatively flat areas joining inland and coastal waters (including debris cones and floodprone areas of offshore islands) including, at a minimum, that area subject to a one percent (100-year occurrence) or greater chance of flooding in any given year.

Forb -- Any herbaceous plant species other than those in the Gramineae (grasses), Cyperaceae (sedges), and Juncaceae (rushes) families. Fleshy-leaved plants.

Forest Land -- Land at least ten percent occupied by forest trees of any size. Also refers to land that formerly had such tree cover, and which is not currently developed for non-forest use.

Formulation -- The form in which a pesticide is packaged or prepared for use. A chemical mixture that includes a certain percentage of active ingredient (technical chemical) with an inert carrier.

Fuel -- Living or dead plant material that will burn.

Fuel Break -- A lane through forest or rangeland from which most combustible material, including trees and shrubs, has been removed or markedly reduced to prevent spread of fire.

Fuel Hazard -- A supply of fuel that forms a special threat of ignition or suppression difficulty.

Fuel Loading -- The amount of fuel present expressed quantitatively as weight of fuel per unit area; generally expressed in tons per acre.

Fuel Management -- The practice of planning and executing the treatment or control of living and dead vegetative material, primarily for wildfire hazard reduction.

Fuel Type -- An identifiable association of fuel elements of distinctive species, forms, sizes, arrangements or other characteristics. A given fuel type will cause a predictable rate of fire spread (or difficulty of control), depending on the specific weather conditions.



Goods and Services -- The various materials produced by (or uses that take place among) forest and rangeland resources.

Ground Fuel -- That fuel lying on or within six feet of the mineral soil surface.

Guideline -- An indication or outline of policy or conduct.



Habitat -- The total environmental conditions of a specific place occupied by a wildlife or plant species, or a population of these species.

Half-life -- The time required for a chemical to be reduced to half of its original amount. The amount may be reduced by excretion, metabolic decomposition, or other natural processes.

Herbicide -- A chemical substance used for killing plants.

Hiding Cover -- Vegetation capable of hiding 90 percent of a standing adult elk from the view of a human at a distance equal to or less than 61 meters (200 feet). Generally, the term refers to any vegetation used by elk for security or escape from danger.

Humus -- A general term for decomposed (plant and animal) residues in the soil. Litter on top of the ground is therefore excluded. More specifically, humus is the more or less stable fraction from the decomposed soil organic material. It is generally amorphous, colloidal, and dark-colored.



Impact, Economic, Direct -- Impacts caused directly by forest product harvest or processing, or forest uses.

Impact, Economic, Indirect -- Impacts that arise from supporting industries selling goods or services to directly-affected industries.

Impact, Economic, Induced -- Impacts resulting from employees or owners of directly or indirectly-affected industries spending their income within the economy.

Implementation Plan -- Detailed action document that translates the selected vegetation management alternative into on-the-ground instructions.

Inhalable Particulates -- Particulates less than 10 microns in diameter that are not filtered from the air, and consequently are inhalable into the upper respiratory system.

Integrated Pest Management -- A process for selecting strategies to regulate forest pests in which all aspects of a pest-host system are studied and weighed. The information considered in selecting appropriate strategies includes the impact of the unregulated pest population on various resources values, alternative regulatory tactics and strategies, and benefit and cost estimates for these

alternative strategies. Regulatory strategies are based on sound silvicultural practices and the ecology of the pest-host system. They consist of a combination of tactics, such as timber stand improvement plus selective use of pesticides. A basic principle in the choice of strategy is that it be ecologically compatible or acceptable.

Interactions -- When chemicals are mixed together, they may have substantially different toxicity than the sum of the toxicities of the components. The chemicals may interact to increase toxicity (synergism) or to decrease toxicity (antagonism).

Inversion -- A layer in the atmosphere where temperature increases with height. Inversions tend to trap smoke beneath them: thus they are a factor to consider in planning and conducting prescribed burns.



K-V (Knutson-Vandenberg Act) -- An act of Congress which among other things authorizes the Forest Service to use funds collected from timber sales for tree planting, timber stand improvement, and other forest uses.



Ladder Fuels -- Burnable materials, living and dead, which tend to be continuous between ground fuels and tree crowns. Thus they form a "ladder" that can allow fire to into the tree crowns.

Landing -- A site where logs, harvested during a timber sale, are stored prior to removal from the Forest.

Land Management Planning -- The process of organizing the development and use of lands and resources in a manner that will best meet the needs of people over time. A major objective is providing enough flexibility to maintain a combination of resource uses in the future.

Last Option, Last Resort -- Terms used to indicate that all other methods would be preferred to a given method (for example, in Alternative D, the use of herbicides) of vegetation management. Other methods would be used unless they were impractical or would generate unreasonable costs.

LC50 -- A lethal concentration rate at which 50 percent of the test animals will be killed. Usually expressed in parts per million (ppm), and usually used in testing of fish or other aquatic species.

LD50 -- A lethal dosage rate at which 50 percent of the test animals will be killed. Usually expressed in terms of milligrams of chemical per kilogram of body weight of the test animal (mg/kg).

Leaching -- Usually refers to movement of chemical through the soil by water. Leaching may also refer to movement of herbicides out of leaves, stems, or roots into the air or soil.

Lifestyle -- The characteristic way people live, indicated by consumption patterns, work, leisure, and other activities.

Long-Term Sustained Yield Timber Capacity- The highest uniform wood yield from lands being managed for timber production that may be sustained under a specified management intensity, consistent with multiple-use objectives.



Maintenance -- A strategy used in the alternatives requiring relatively small doses of energy and resources to perpetuate a stable condition.

Management Concern -- An issue, problem, or condition that constrains the range of management practices identified by the Forest Service in the planning process.

Management Direction -- A statement that includes multiple use and other goals and objectives; the associated management strategies; and standards and guidelines for attaining them.

Management Intensity -- A management practice or combination of management practices and associated costs designed to obtain different levels of goods and services.

Management Practice -- A specific action, measure, course of action, or treatment.

Management Strategy -- Management practices and intensity selected and scheduled for application on a management area to obtain multiple use and other goals and objectives.

Mass Wasting -- Movement of soil or rock on slopes by gravitational forces and not directly by running water, usually involving movement of a portion of land surface. It includes slow displacement (such as creep) and rapid movement such as earthflows, rock slides, and avalanches.

Maximum Modification (Visual) -- See Visual Quality Objective.

MBF -- Thousand board feet.

Method -- A body of techniques. This document discusses five methods: biological and grazing; prescribed burning; manual; mechanical; and herbicides.

Microbial Degradation -- The breakdown of a chemical substance into simpler components by bacteria.

Micron -- One millionth of a meter; a micrometer.

Microorganism -- A living organism so small that it can be seen only with a microscope.

MIH -- Management Information Handbook.

Minority -- Persons as specified in Directive 15, Office of Federal Statistical Policy and Standards, U. S. Department of Commerce, Statistical Policy Handbook (1978). Generally identified as one of the following four categories: Alaskan Native or American Indian, Asian or Pacific Islander, Black, Hispanic.

MMBF -- Million board feet.

Municipal Watershed -- A watershed which provides water for human consumption, where Forest Service management could have a significant effect upon the quality of water at the intake point, and that provides water utilized by a community or any other public water system regularly serving at least 25 individuals at least 60 days out of the year, or provides at least 15 service connections, to include campground, organization camps, resorts, residential areas. The intake point for the supply does not have to be within the Forest boundary. An area would not be managed by the Forest Service as a municipal watershed if the intake is some distance

downstream from National Forest land and there is intervening pollution sources that exceed National Forest effects.



National Ambient Air Quality Standards -- Allowable concentrations of certain air pollutants in the ambient air as specified by the federal government (40 CFR Part 50). Ambient air quality standards are divided into primary and secondary standards. Primary standards are designed to protect public health; secondary standards are designed to protect public welfare. Effects affecting public welfare include—but are not limited to—effects on soils, water, crops, vegetation, animal, weather, and visibility. Standards have been developed for carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, ozone, and particulate matter.

Natural Fuels -- Fuels that are a result of natural processes such as blowdown, insect epidemics, and other causes of mortality.

NEPA -- The National Environmental Policy Act of 1969.

NEPA Process -- A process, mandated by NEPA, that concentrates decisionmaking around issues, concerns, alternatives and the effects of alternatives on the environment.

Net Value Change -- The difference in value of planned resource outputs on an area before and after a fire.

NFMA -- The National Forest Management Act of 1976.

NFMAS -- National Fire Management Analysis System. A computer-based simulation system that tests the effectiveness of a proposed fire suppression organization and/or fire management strategy, program, or policy.

No Action -- See Current Direction. Also one of four strategies used in the alternatives. No action means no interference with natural processes by man.

Nominal Dollars -- A value from which the effect of change in the purchasing power of the dollar has not been removed.

Nonattainment Area -- An area designated by EPA as not meeting federal ambient air quality standards.

Nondeclining Evenflow -- A harvest schedule for timber or any other resource in which the average annual harvest may increase or remain static through time, but never decrease.

Noxious Weeds -- Species of plants that cause disease or are injurious to crops, livestock, or land.



Old-growth -- An old-growth stand is defined as any stand of trees ten acres or greater in size, which generally contains the following characteristics: 1) contains mature and overmature trees in the overstory that are well into the mature growth stage; 2) usually contains a multi-layered canopy and trees of several age classes; 3) standing dead trees and down material are present; and 4) evidence of human activities may be present, but do not significantly alter the other characteristics, and are a subordinate factor in describing the stand.

Opportunity Cost -- The dollar-quantifiable net loss resulting from selecting a less efficient course of action.

Overstory -- The portion of trees in a forest which forms the uppermost layer of foliage.



Pacific Northwest Region -- Includes the States of Oregon and Washington, portions of two counties in California, and parts of three counties in Idaho. The Region (sometimes called "Region 6") contains 19 National Forests and one National Grassland.

Particulate -- Any dispersed aggregate matter—solid or liquid (other than water)—suspended in or falling through the atmosphere.

Payments to Local Governments -- Payments to local or state governments based on ownership of Federal land that do not directly depend on production of goods and services or receipt-sharing. Specifically, they include payments made under the Payments in Lieu of Taxes Act of 1976 by the U. S. Department of the Interior.

Permittee -- A holder of a permit to use National Forest land for a specific purpose.

Person-day -- The equivalent to one person working for eight hours.

Phenoxy Herbicides -- Chemicals having herbicidal properties and a chemical structure consisting of a phenyl ring attached to an oxygen, which is in turn attached to a carboxylic group. Examples of phenoxy herbicides are 2,4-D; MCPA; 2,4,5-T; and 2,4,5-TP (Silvex).

Photodecomposition -- The breakdown of a substance—especially a chemical compound—into simpler components by the action of radiant energy.

Pioneer Species -- A plant capable of invading bare sites (e.g., a newly exposed soil surface) and persisting there (i.e. "colonizing" them) until supplanted by other species.

Planned Ignition -- A fire started by a deliberate management action.

PM-2.5 -- References proposed air quality standard for particulate matter less than 2.5 microns in diameter.

PM-10 -- References proposed air quality standard for particulate matter less than 10 microns in diameter.

PNV -- See Present Net Value.

Policy -- A guiding principle used as the basis for a specific decision or set of decisions.

Potential Yield -- The sustainable output level of wood fiber available after deductions for other resource needs.

Ppb -- Parts per billion.

Ppm -- Parts per million.

Precommercial Thinning -- Any type of thinning (cutting or otherwise killing trees in a stand) that takes place before the size or condition of the trees make them of sufficient value to cover the costs of the activity.

Prescribed Burning -- Intentional application of fire to forest or rangeland in their natural or modified state to meet specific management objectives.

Prescription (Silvicultural) -- The formal written plan of action to carry out a silvicultural treatment of a forest stand to achieve specific objectives.

Present Net Value -- Discounted benefits less discounted costs.

Present Net Worth -- See Present Net Value.

Preservation (Visual) -- See Visual Quality Objective.

Prevention -- One of four strategies used in the alternatives. Prevention requires early action, well before competition or plant cover causes damage, and relatively small amounts of energy and resource input.

Prevention of Significant Deterioration (PSD) -- A program identified by the Clean Air Act to prevent air quality and visibility degradation and to remedy existing visibility problems. Areas of the country are grouped into three classes which are allowed certain degrees of pollution depending on their uses (See Class I, II, and III Areas).

Programmed Harvest -- Timber scheduled for harvest for a specific year.

Public Issue -- A subject or question of widespread public interest relating to management of the National Forest System.

PUM -- Piling of unmerchantable material.

R

Rate-of-Return -- The annualized net profit on an investment, expressed as a percentage.

Rate of Spread -- The amount that a fire extends its horizontal dimensions within a unit of time. This can be expressed as forward rate of spread of the advancing fire front; area increase rate; or perimeter increase rate.

Ravel -- Downslope movement of sediment particles or small rocks on steeper slopes without flowing water. The particles are dislodged by a combination of gravity; changes in temperature; wetness and wind; or by animals.

Real Dollar Value -- A monetary value that compensates for the effects of inflation.

Recreation Opportunity Spectrum (ROS) -- An array of recreational activities, settings, and experiences used as a basic framework in planning and managing the recreation resource. This spectrum is divided into the following classes: primitive, semiprimitive nonmotorized, semiprimitive motorized, roaded natural, rural, and urban.

Recreation Visitor Day -- The use of an area by one or more people for 12 person-hours, either continuously or spread over several visits. One person visiting a recreation site for one day (12 hours) is one recreation visitor day (RVD).

Reforestation -- Reforestation includes measures to obtain natural regeneration, as well as tree planting and seeding. The work is done on National Forests to produce timber and other forest products, protect watersheds, prevent erosion, and improve other social and economic values of the forests, such as wildlife, recreation, and natural beauty.

Regeneration -- The renewal of a tree crop, whether by natural or artificial means. Also the young tree crop itself.

Regional Haze -- A haze with no attributable source, occurring over a large area.

Research Natural Area -- An area, typifying an important forest, shrubland, grassland, alpine, aquatic, or geologic type or other natural situation (with special or unique characteristics) set aside to provide a benchmark for education and research.

Respirable Particulate Matter -- That portion of the total particulate matter that has an especially long residence time in the atmosphere and penetrates deeply into the lungs. These characteristics are due to size (smaller than 2 to 3 microns).

Riparian Habitat -- That portion of a watershed or shoreline influenced by surface or subsurface waters, including stream or lake margins, marshes, drainage courses, springs, and seeps.

Riparian Vegetation -- Nonaquatic vegetation found within riparian areas. Typically, this vegetation depends on a seasonally high water table.

Risk Assessment -- An analytic process that is firmly based on scientific considerations, but also requires judgments to be made when the available information is incomplete. These judgments inevitably draw on both scientific and policy considerations.

Risk Characterization -- Describes the nature and magnitude of the human risk. Risk characterization uses information gathered in other stages to represent the overall situation. The assessment of toxicity, along with levels and probability of exposure, are joined to estimate risk.

Risk Management -- The process of weighing policy alternatives and selecting the most appropriate regulatory action; integrating the results of risk assessment with engineering data and with social, economic and political concerns to reach a decision.

Rotation (when referring to timber) -- The period of years between the initial establishment of a timber stand and the time when it is considered ready for cutting and regeneration.

Rural -- See Recreation Opportunity Spectrum.



Scablands -- Shallow-soiled lands typically dominated by such species as low and stiff sagebrush.

Scoping Process -- A process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action.

Sedimentation -- Transport of eroded soils to a stream channel.

Seed Orchard -- A plantation of selected clones or tree progenies. The orchard is isolated or managed to avoid or reduce pollination from outside sources. The object is to produce frequent, abundant and easily harvested crops of seed.

Sensitive Species (list) -- A list maintained by the Region of sensitive species that have particular scientific or management value, nationally or locally. These species may be locally rare (abundant elsewhere) or have a limited population. The list includes species

from state and Federal lists. By law, federally-listed species must be protected.

Seral -- A biotic community (in an ecologic succession) that is in a developmental, transitory stage.

Serotiny -- Cones that require heat to open and release seeds.

Shade Tolerant Trees -- Trees that are able to grow in shade from trees or other plants above them. Shade tolerant trees sometimes reproduce and form understories beneath canopies of trees that are less able to tolerate shade, thus changing the species composition of the stand.

Shade Intolerant Trees -- Trees that are not able to grow well in the shade from other trees or plants. Shade intolerant trees thus reproduce successfully only in the open or where the canopy is greatly broken.

Silvicultural System -- A management process of tending, harvesting, and replacing forests. Each silvicultural system results in a forest with a distinctive form. Systems are classified according to the method of carrying out the fellings that remove the mature crop and provide for regeneration, and according to the type of forest that results.

Silviculture -- The art and science of controlling the establishment, composition, competition, and growth of forests.

Slash -- The vegetative residue left on the ground after trees are felled, or which accumulates as a result of storm, fire, or silvicultural treatment.

Smoke Management -- Keeping the impact of smoke on the environment within acceptable limits by conducting prescribed fire activities when fuel moisture and weather conditions are optimum, using specific firing (ignition) techniques.

Smoke Sensitive Area -- An area that may be negatively impacted by smoke, but is not classified as a designated area.

Social Organization -- The structure of a society described in terms of institutions, community cohesion, and community stability.

Sorption -- The ability of particulate matter to bind another substance either to its surface or its interior.

Stable Atmosphere -- A layer in which the vertical movement of air is damped. An emission would not "mix" vertically in a stable atmosphere, hence dilution would be very slow.

Standard -- A principle requiring a specific level of attainment, a rule against which to measure.

State Implementation Plan (SIP) -- A document which describes a comprehensive plan of action for achieving specified air quality objectives and standards for a particular locality or region within the state, within a specified time period.

Strategy -- A carefully planned course of action. Four strategies are incorporated into the alternatives presented: no action; prevention; correction; and maintenance.

Successional Stage -- A stage or recognizable condition of a plant community that occurs as the community develops (stage by stage) from bare ground to climax condition.

Suitability -- The appropriateness of applying particular resource management practices to a given land area. Suitability is determined by an analysis of the economic and environmental consequences of the practices, and the alternative uses foregone. A unit of land may be suitable for a variety of individual or combined management practices.

Suitable -- See Commercial Forest Land.

Summer Range -- A portion of the total range on which big-game animals normally find food and cover during summer months.

Supply -- The amount of an output that producers are willing to provide at a specific price, during a given time period, under given conditions of sale.

Suppression -- Action to limit the spread of—and prevent damage by—wildfires.

Sustained Yield of Products and Services -- The achievement and maintenance in perpetuity of a high level of production of various renewable resources on an annual or regular periodic basis, without impairing the productivity of the land.



Technique -- How a basic method is used.

Theme -- A theme characterizes the quality of an action.

Thermal Cover -- Cover used by animals to ameliorate effects of weather. For example, for elk, thermal cover is provided by a stand of coniferous trees 12 meters (40 feet) or more tall with an average crown closure of 70 percent or more. For deer, thermal cover may include saplings, shrubs, or trees at least 1.5 meters (5 feet) tall, with 75 percent crown closure.

Thinning -- A way of improving a young or immature stand of trees by cutting some of them. Thinning is done primarily to accelerate diameter increment. By carefully selecting the trees to be left, thinning is also used to improve the average form of the trees that remain. According to classical concepts, thinning is done in such a way that permanent breaks in the tree canopy are not produced.

Threatened Species -- Any species listed in the Federal Register, which is likely to become an endangered species within the forseeable future throughout all or a significant portion of its range.

Timber Production -- The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use. For purposes of this definition, the term "timber production" does not include production of fuelwood.

Tolerance -- The forestry term for expressing the relative capacity of a tree to compete under low light and high root competition.

Tool -- An instrument used for a vegetation management activity. For example, in this document, a brush blade or chain-saw is considered a tool used in manual methods.

Total Suspended Particulate Matter (TSP) -- Amount of particulate materials of all sizes (mass basis) suspended in a unit volume of the atmosphere at a point in time.

Toxic – The term relates to a harmful effect by a poisonous substance on the human body, whether contact with the substance is through physical contact, ingestion, or inhalation.

Toxicologic Hazard Identification – Determines whether or not a particular chemical is causally linked to an adverse health outcome.

Tractor Logging – In timber harvesting, any logging method using a tractor or other mobile surface unit as the motive power to drag or carry logs from the stumps to a collecting point.

Transitory Range -- Land that is suitable for temporary use for grazing. For example, on particular disturbed lands, grass may cover the area for a period of time before being replaced by trees or shrubs not suitable for forage.

Transportation Corridor – See Corridor.



Uncertainty – May be due to missing information, or gaps in scientific theory. Whenever uncertainty is encountered, a decision, based upon scientific knowledge and policy considerations, must be made. The term scientific judgment is used to distinguish this decision from policy decisions made in risk management.

Understory – In silviculture, trees growing under the canopy formed by taller trees; in range management, herbaceous and shrub vegetation under a brushwood or tree canopy.

Unplanned Ignition – A fire started at random by either natural or human causes, or a deliberate incendiary fire.

Unproductive – Refers to timber production; specifically forest land that does not grow 20 cubic feet per acre per year of merchantable timber.

Unregulated – Timber which was not considered (because of land allocations or condition of trees) in calculating a base sale schedule or departure schedule. Unregulated timber volume can come from salvage of trees killed by insect epidemics; from cull material; or from green timber on lands considered "unsuited".

Unstable Atmosphere -- A layer in which the vertical movement of air is enhanced. An emission would mix rapidly in an unstable atmosphere; hence, dilution would be very efficient.

USDA -- United States Department of Agriculture.

USDI – United Stated Department of the Interior.

Utilization – Methods that reduce vegetative residue through improved harvest techniques, or through higher utilization standards.

Utility Corridor – See Corridor.



Value, Market – The unit price of an output normally exchanged in a market after at least one stage of production, expressed in terms of

what people are willing to pay (based on the evidence of market transactions).

Value, Non-Market – The unit price of a non-market output not normally exchanged in a market at any stage before consumption. This value is imputed from other economic information.

Visibility – How far a given object can be seen by the human eye. The greatest distance in a given direction at which it is just possible to see and identify, with the unaided eye in the daytime, a prominent dark object and, at night, a known, preferably unfocused, moderately intense light source.

Visibility Impairment – Any humanly perceptible change in visibility (visual range, contrast, coloration) from that which would have existed under natural conditions. See section 169(g)6 of the Clean Air Act.

Visual Quality Objective – A combination of inherent scenic quality and public interest that defines the acceptable degree of alteration for any given area.

Volatilization -- Vaporization of a substance.



Wetlands – Those areas inundated by surface or ground water often enough to support (or which do support) the kind of vegetation or aquatic life that requires saturated (or seasonally saturated) soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats and natural ponds.

Wilderness – Lands designated by law as wilderness. Road building and timber harvesting are not allowed on these lands, which are intentionally managed to maintain their primitive character.

Wildfire – Any wildland fire that requires a suppression response.

Winter Range – A range, usually at lower elevation, used by migratory deer and elk during the winter months. Winter ranges are usually smaller and better-defined than summer ranges.



YUM – Yarding of unmerchantable material to the landing.

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